
PC 99 Addendum

**Clarifications and corrections to
PC 99 System Design Guide,
a technical reference for designing
PCs and peripherals for the
Microsoft® Windows® family
of operating systems**

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Intel Corporation and Microsoft Corporation**

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Contents

| | |
|--|-----------|
| Welcome | 5 |
| How to Use This Addendum..... | 5 |
| Conventions Used in This Guide | 5 |
| References and Resources..... | 6 |
| Chapter 1..... | 7 |
| PC 99 Clarifications and Corrections | 7 |
| Addendum for PC 99 Basic Requirements | 7 |
| Addendum for Workstation PC 99..... | 13 |
| Addendum for Entertainment PC 99..... | 14 |
| Addendum for Mobile PC 99..... | 15 |
| Addendum for USB..... | 19 |
| Addendum for IEEE 1394..... | 19 |
| Addendum for PCI..... | 23 |
| Addendum for ATA and ATAPI | 26 |
| Addendum for SCSI..... | 27 |
| Addendum for PC Card..... | 29 |
| Addendum for I/O Ports and Devices..... | 30 |
| Addendum for Graphics Adapters | 34 |
| Addendum for Video and Broadcast Components..... | 37 |
| Addendum for Monitors | 41 |
| PC 99A Recommendations for Digital Visual Interface..... | 41 |
| Addendum for Audio Components | 44 |
| Addendum for Storage and Related Peripherals..... | 47 |
| Addendum for Modems..... | 51 |
| Addendum for Network Communications..... | 55 |
| Addendum for Printers | 58 |
| Addendum for Digital Still Image Devices | 61 |
| Chapter 2..... | 63 |
| References..... | 63 |

Welcome

The *PC 99 Addendum* supplements *PC 99 System Design Guide* in providing a guide for engineers who build personal computers, expansion cards, and peripheral devices that will be used with the Microsoft® Windows® 32-bit operating systems and that incorporate legacy components.

PC 99 System Design Guide (Microsoft Press, 1998; ISBN 0-7356-0518-1) is available on the web at <http://www.pcdesguide.org>.

How to Use This Addendum

This Addendum is divided into the following chapters.

| Chapter | Contents |
|--|---|
| 1: PC 99A Clarifications and Corrections | Presents the complete list of technical clarifications and errata for this addendum. |
| 2: References | Presents a master list of specifications and references from <i>PC 99 System Design Guide</i> , with updated web and other source references. |

This guide is co-authored by Intel Corporation and Microsoft Corporation.

Reference and PC design guide documents, including *PC 99 System Design Guide*, are available on the web site at <http://www.pcdesguide.org>, which is jointly owned and managed by Microsoft and Intel.

Conventions Used in This Guide

The following conventional terms are used throughout this guide.

Add-on devices

Devices that are traditionally added to the base server system to increase functionality, such as audio, networking, graphics, and so on. Add-on devices fall into two categories: devices built onto the system board set and devices on expansion cards added to the system through a system-board connector such as Peripheral Component Interconnect (PCI).

Intel Architecture

Refers to computers based on 64-bit and 32-bit microprocessors that use the Intel Architecture instruction set, such as Intel® Pentium® Intel Pentium with MMX™

technology, Pentium Pro, Pentium II, Pentium II Xeon,TM Pentium III[®] or compatible processors. MMX technology refers to Intel's media-enhancement technology that includes new instructions added to the Intel Architecture instruction set.

Legacy

Refers to any feature in the system based on older technology for which compatibility continues to be maintained in other system components.

System devices

Also *on-board devices*. Refers to devices on the system board set such as interrupt controllers, keyboard controller, real-time clock, direct memory access (DMA) page registers, DMA controllers, memory controllers, floppy disk controller (FDC), AT-Attachment (ATA) ports, serial and parallel ports, PCI bridges, and so on. In today's servers, these devices are typically integrated with the supporting chip set.

Windows

Refers to the Windows 98 operating systems, including any add-on capabilities and any later versions of the operating system.

Windows 2000

Refers to the Microsoft Windows 2000 operating system, including any add-on capabilities and any later versions of the operating system.

References and Resources

The following represents some of the information resources, services, and tools available to help build hardware optimized to meet the requirements defined in this guide. A complete list of technical references for this addendum is provided in Chapter 2.

Information Resources

PC Design Guide references and resources

<http://www.pcdesguide.org>.

Intel developer information

<http://developer.intel.com>

Microsoft hardware developer information

<http://www.microsoft.com/hwdev/>

Microsoft Developer Network (MSDN) Professional Subscription

<http://msdn.microsoft.com/>

Phone: (800) 759-5474

Outside North America: (510) 275-0763

Fax: (510) 275-0762

 CHAPTER 1

PC 99 Clarifications and Corrections

This chapter provides clarifications and corrections to the original requirements and recommendations defined in *PC 99 System Design Guide*. Unless explicit information is provided for a particular item in this list, the guidelines remain as originally defined in *PC 99 System Design Guide*.

Items that refer to the specific Windows operating system based on Microsoft Windows NT® technologies have been updated to refer to Windows 2000 (from Windows NT 5.0).

Note:

- Recommended features described in *PC 99 System Design Guide* are not expected to become requirements *unless the expectation is explicitly stated in the text*. If you implement a recommended feature, you must meet the implementation guidelines defined in *PC 99 System Design Guide* because these recommendations are based on the support built into Windows 98 and Windows 2000.
- Optional features will not become requirements in the future. Typically, "optional" indicates a feature or functionality that is not an element of a Design Guide initiative; however, implementation guidelines are provided to ensure compatibility with Windows operating systems.

Addendum for PC 99 Basic Requirements

| | Consumer | Office | Mobile | Workstation | Entertainment |
|------|--|----------|----------|-------------|---------------|
| 3.1. | System performance meets PC 99 minimum requirements | | | | |
| | 300 MHz, | 300 MHz, | 233 MHz, | 400 MHz, | 300 MHz |
| | 32 MB | 64 MB | 32 MB | 128 MB | 64 MB |

Technical Correction for workstations: The minimum required L2 cache is 256K per processor.

Technical Clarifications for multiprocessor systems:

1. PCI IRQ Routing on Multiprocessors. For information about the requirements for PCI IRQ routing on a multiprocessor Advanced Configuration and Power Interface

(ACPI) system, see PCI IRQ Routing on a Multiprocessor ACPI System at <http://www.microsoft.com/hwdev/onnnow/acpi-mp.htm>.

2. Multiprocessor Wakeup. A problem has been uncovered with certain multiprocessor systems that will prevent them from properly waking up from a Sleep state under Windows 2000. This pertains to dual-processor or multi-processor systems that transition all processors from an active state to a STPCLK state, and more specifically to systems where all processors receive their STPCLK# request from one source.

Prior to transitioning from a STPCLK state to a Sleep state or lower power state, all processors must generate a Stop Grant Bus cycle. It is essential that all processors have transitioned into the STPGNT state before it is safe to: 1) transition to a lower power state such as Sleep, or 2) externally shut off the processor clocks to allow for flushing buffers, cache maintenance, and other internal activities.

For dual-processor and multiprocessor systems using a single STPCLK to all processors and a single SLP pin to all processors, the transition to the Sleep state should not be used. Behavior of the system during removal of the processor clocks such as transitions from STPCLK to Sleep state cannot be guaranteed unless all STPGNT bus cycles are received.

For example, *Intel®Xeon™ Specification*, Section 4.2.5 Sleep State-State 5, specifies that for a multiprocessor system, all processors are required to complete the Stop Grant bus cycle before the subsequent 100 BCLK waiting period and before the assertion of SLP# can occur. When multiple processors are serviced by a single STPCLK request to all processors and a single SLP, there is no provision to guarantee that all Stop Grant bus cycles are received before the assertion of SLP.

As another example, in 450NX-based platforms from Intel, the STPCLK# from PIIX4E is connected to all processors, and SLP# from PIIX4E is connected to all processors. The following sequence occurs:

- t0. Operating system writes PMCNTRL register.
- t1. PIIX4E asserts STPCLK#, then waits for Stop Grant acknowledgment.
- t3. The processor acknowledges with Stop Grant ACK cycle.
- t4. PIIX4E asserts SLP# after receiving this.

This sequence works for uniprocessor systems (which is what the PIIX4E was originally designed for). However, in multiprocessor systems, SLP# might be asserted to a processor that is not in Processor Sleep State 3 (that is, not yet acknowledged). This premature SLP# assertion might result in a wakeup problem.

Intel provides additional information about this issue through the Intel Technical Support Hotline at 1-800-628-8686 (outside North America at 1-916-377-7000).

For more information, see <http://www.microsoft.com/hwdev/winlogo/99logo.htm>.

3.2. System design meets ACPI 1.0 specification and PC 99 requirements

Required for all system types, with exceptions for mobile PCs

Note: *ACPI Specification, Revision 1.1* has been published on the ACPI web site at <http://www.teleport.com/~acpi/>. The draft process for Revision 2.0 is underway, as of Q1 1999.

3.3. Hardware design supports OnNow and Instantly Available PC initiatives*Required for all system types, with exceptions for mobile PCs***3.4. BIOS meets PC 99 requirements for OnNow support***Required for all system types***3.5. BIOS meets PC 99 requirements for boot support***Required for all systems, with exceptions for mobile PCs***Technical Clarifications for "BIOS supports preboot execution environment, with unique system ID provided in print" (PC99:3.5.1):**

1. PXENV specifications. The specification cited for a unique PXENV system identifier is *Network PC System Design Guidelines, Version 1.0b*, plus the additional information in the related FAQ at <http://www.microsoft.com/hwdev/netpc.htm>. This is the specification upon which the Windows 2000 implementation was based; it is not the later information defined in *Wired for Management, Version 2.0* or later. As indicated in *PC 99 System Design Guide*, one possible implementation for remote boot is defined in *Wired for Management, Version 1.1a*.

Mobile PC Note

2. Mobile PCs. Only mobile PCs that ship with an integrated network adapter are required to provide the unique system ID in printed form. The initial use of the unique system ID will be for creating a Machine Account Object for the remote installation service. Currently, no Microsoft operating system supports remote installation using a PC Card network adapter.

3.6. All expansion slots in the system are accessible for users to insert cards*Required for all system types, with extra guidelines for mobile*

Clarification for AGP and requirement for expansion slots to be accessible to end users: For designs implementing the proposed AGP Pro specification, the two PCI slots adjacent to the component side of the AGP Pro slot may be blocked and used by an AGP Pro Adapter. When the AGP Pro connector is used by a "standard" AGP board, the PCI connectors must be accessible and available for use with PCI cards.

3.7. Audible noise meets PC 99 requirements*Required for all system types***3.8. System and component design practices follow accessibility guidelines***Recommended for all system types***3.9. Internal system modification capabilities are not accessible to end users***Recommended for all system types***3.10. System design provides physical security***Recommended for all system types***3.11. Each device and driver meets PC 99 device requirements***Required for all system types***3.12. Each bus and device meets Plug and Play specifications***Required for all system types***3.13. Unique Plug and Play device ID provided for each system device and add-on device***Required for all system types***3.14. Option ROMs meet Plug and Play requirements***Required for all system types*

- 3.15. ***“PNP” vendor code used only to define a legacy device’s Compatible ID***
Required for all system types
- 3.16. ***Device driver and installation meet PC 99 requirements***
Required for all system types
- 3.17. ***Minimal user interaction needed to install and configure devices***
Required for all system types
- 3.18. ***Connections use icons, plus keyed or shrouded connectors, with color coding***
Required for all system types, with exceptions for mobile PCs

Technical Clarification to color coding requirements: Color coding is required for PC systems, but the color codes listed in *PC 99 System Design Guide* are only recommended. The intent is to standardize the industry on a single color-coding scheme, so these specific colors will become a requirement for systems in future versions of the design guidelines.

For retail peripherals, color-coding is *not* required. However, if color codes are implemented on peripheral devices, the scheme *must* follow the color codes listed in *PC 99 System Design Guide*. See the color coding FAQ at <http://www.pcdesguide.com/documents/pc99icons.htm>. For questions and issues about color coding, send e-mail to **comments@pcdesguide.com**.

- 3.19. ***Hot-plugging capabilities for buses and devices meet PC 99 requirements***
Required for all system types
- 3.20. ***System includes Device Bay 1.0-compatible bay***
Recommended for all system types
- 3.21. ***Multifunction add-on devices meet PC 99 device requirements for each device***
Required for all system types

Technical Clarification: The PC 99 exception for multifunction PCI devices that use only a single set of relocatable resources refers solely to multifunction devices *of the same device class*. If different functions within a multiple-function device require separate class drivers—for example, a combination PCI network adapter and modem—then each function must provide a unique PCI SID and SVID that will allow the proper driver to be loaded for each separate function.

Multifunction devices that contain functions from separate classes will not be properly recognized during an operating system upgrade and therefore drivers will not be properly upgraded unless unique IDs are provided for each device.

Note that a “supervisory” driver that loads different drivers for the individual functions does not work well with Windows. In particular, driver support is likely to be lost in cases of operating system re-installation or upgrade, or with distribution of new drivers via Windows Update. Therefore, these supervisory drivers should be avoided. Future versions of the Design Guide will require separate drivers for separate functions.

- 3.22. ***All devices support correct 16-bit decoding for I/O port addresses***
Required for all system types

- 3.23. All PC 99 input devices support Microsoft DirectInput and work simultaneously**
Required for all system types
- Technical Clarification:** The built-in class drivers support simultaneous operating of multiple input devices. For information about implementing support for other drivers, see Part 4: Drivers for Input Devices in the Kernel-Mode Drivers Design Guide of the Windows 2000 DDK. See also the sample code and documentation in the Windows 98 DDK at %98DDK%\src\hid\ and in the Windows 2000 DDK at %NTDDK%\src\wdm\hid\.
- 3.24. Each bus meets written specifications and PC 99 requirements**
Required for all system types
- 3.25. System includes USB with two USB ports, minimum**
Required for all system types, with exceptions for mobile PCs
- 3.26. System includes support for IEEE 1394**
Recommended for all system types, with 3 ports recommended for Entertainment PCs
- 3.27. If present, PCI bus meets PCI 2.1 or later, plus PC 99 requirements**
Required for all system types
- 3.28. System does not include ISA expansion devices or slots**
Required for all system types
- Note:** Compliance testing for this requirement will begin January 1, 2000.
- 3.29. System includes keyboard connection and keyboard**
Required for all system types
- 3.30. System includes pointing-device connection and pointing device**
Required for all system types
- 3.31. System includes connection for external parallel devices**
Required for all system types
- 3.32. System includes connection for external serial devices**
Required for all system types
- 3.33. System includes IR devices compliant with IrDA specifications**
Recommended for all system types
- 3.34. System includes PC 99-compatible CD or DVD drive and controller**
Required Recommended Recommended Required DVD required
- 3.35. System includes audio support that meets PC 99 requirements**
Recommended Recommended Recommended Recommended Required
- 3.36. System includes a modem or other public network communications support**
Required Recommended Required Recommended Required
- Errata:** A modem or other communications support is **not** required for Workstation systems.
- 3.37. System includes a network adapter**
Recommended Required Recommended Required Recommended
- 3.38. System includes smart card support**
Recommended for all system types

Technical Clarification: Smart Card SDK is part of the Windows Base Services within the Microsoft Platform SDK. Smart Card driver information is available in 'Smart Card Driver Overview' in the Windows 98 DDK and the Windows 2000 DDK (on the web at http://www.microsoft.com/ddk/ddkdocs/win98ddk/scovr_8ugn.htm and http://www.microsoft.com/ddk/ddkdocs/Win2k/scovr_8ugn.htm, respectively).

3.39. Graphics adapter meets PC 99 minimum requirements

Required for all system types, with specific guidelines for each system type

3.40. Color monitor is DDC-compliant with unique EDID identifier

Required for all system types, with exceptions for mobile PCs

Technical Clarification: The required support defined in Version 3.0 of these standards is also defined in the earlier version and revisions of these standards. As such, the Version 3.0 standards provide the correct references for both Windows 2000 and Windows 98.

3.41. System meets PC 99 DVD-Video and MPEG-2 playback requirements, if system supports DVD-Video

Required for all system types, with exceptions for mobile PCs

3.42. Adapter supports television output if system does not include a large-screen monitor

Recommended for all system types

3.43. System supports PC 99 analog video input and capture capabilities

Recommended for all system types

3.44. System includes analog television tuner

Recommended for all system types

3.45. System BIOS and option ROMs support Int 13h Extensions

Required for all system types

Technical Clarification: This requirement also applies for RAID controllers implemented on client systems such as workstations.

3.46. Host controller for storage device meets PC 99 requirements

Required for all system types

3.47. Host controllers and hard disk devices support bus mastering

Required for all system types

Technical Correction: ATA and ATAPI devices must meet the following support requirements and recommendations for Ultra DMA and IDE Bus Master DMA.

Support for Ultra DMA:

- Required for ATA controllers and ATA devices
- Recommended for ATAPI peripherals
However, ATAPI devices might be connected to the ATA bus (which is required to support UDMA). Therefore, to ensure that ATAPI devices will tolerate Ultra DMA, ATAPI devices must support the termination scheme as defined in ATA/ATAPI-4 or SFF 8038i.

Support for IDE Bus Master DMA:

- Required for ATA controllers
- Required for ATA devices and ATAPI peripherals, including CD and DVD devices
- Recommended for ATA/ATAPI tape drives
- Recommended for ATAPI removable media drives

3.48. Hard drive meets PC 99 requirements*Required for all system types***3.49. Operating system recognizes the boot drive in a multiple-drive system***Required for all system types***3.50. Floppy disk capabilities, if implemented, do not use legacy FDC***Recommended for all system types*

Clarification: It is the intent of *PC 99 System Design Guide* to discourage the use of a legacy floppy drive and to encourage system designers to seek other alternatives for both the installation boot drive and casual storage.

3.51. System supports WHIIG

| | | | | |
|-----------------------|-----------------|---------------------------------------|-----------------|-----------------------|
| <i>Not applicable</i> | <i>Required</i> | <i>Required with Windows 2000</i> | <i>Required</i> | <i>Not applicable</i> |
|-----------------------|-----------------|---------------------------------------|-----------------|-----------------------|

The requirements in items 3.51-3.53 will not be tested or enforced until nine months after *Windows Hardware Instrumentation Implementation Guide* (WHIIG) V.1.0 is published. The current version of WHIIG is available on <http://www.pcdesguide.org>.

3.52. System includes driver support for WMI

| | | | | |
|-----------------------|-----------------|---------------------------------------|-----------------|-----------------------|
| <i>Not applicable</i> | <i>Required</i> | <i>Required with Windows 2000</i> | <i>Required</i> | <i>Not applicable</i> |
|-----------------------|-----------------|---------------------------------------|-----------------|-----------------------|

3.53. Management information service provider enabled by default

| | | | | |
|-----------------------|-----------------|---------------------------------------|-----------------|-----------------------|
| <i>Not applicable</i> | <i>Required</i> | <i>Required with Windows 2000</i> | <i>Required</i> | <i>Not applicable</i> |
|-----------------------|-----------------|---------------------------------------|-----------------|-----------------------|

3.54. Expansion devices can be remotely managed

| | | | | |
|-----------------------|-----------------|--------------------|-----------------|-----------------------|
| <i>Not applicable</i> | <i>Required</i> | <i>Recommended</i> | <i>Required</i> | <i>Not applicable</i> |
|-----------------------|-----------------|--------------------|-----------------|-----------------------|

3.55. SMBIOS 2.2 static table support is provided

| | | | | |
|-----------------------|-----------------|--------------------|-----------------|-----------------------|
| <i>Not applicable</i> | <i>Required</i> | <i>Recommended</i> | <i>Required</i> | <i>Not applicable</i> |
|-----------------------|-----------------|--------------------|-----------------|-----------------------|

Addendum for Workstation PC 99

4.1. Workstation meets all requirements for Office PC 99*Required***4.2. Workstation performance meets Workstation PC 99 minimum requirements***Required*

Technical Correction: The minimum required L2 cache is 256K per processor for Workstation systems.

4.3. Workstation supports multiple processors*Recommended*

- 4.4. **Workstation RAM can be expanded**
Recommended
- 4.5. **Workstation system memory includes ECC memory protection**
Required
- 4.6. **Workstation includes APIC support**
Required
- 4.7. **Workstation includes high-performance components**
Recommended
- 4.8. **Workstation supports 64-bit I/O bus architecture**
Required for 64-bit platforms

Technical Clarification: All PCI adapters, including 32-bit PCI adapters, must be able to address the full physical address space on a 64-bit platform. For 32-bit PCI adapters, this means that they must be able to support the Dual Address Cycle (DAC) command to permit them to transfer 64-bit addresses to the adapter or device (that is, addresses that are above the low 4 GB address space). Adapters that cannot provide this support will not be able to access the full address space on a 64-bit platform.
- 4.9. **Workstation does not include ISA expansion slots**
Required
- 4.10. **Graphics subsystem supports workstation performance demands**
Required, with special conditions depending on PC 99 market category
- 4.11. **Storage components rely on SCSI controller**
Recommended
- 4.12. **Workstation includes multiple hard drives**
Recommended

Addendum for Entertainment PC 99

- 5.1. **System performance meets Entertainment PC 99 minimum requirements**
Required
- 5.2. **Entertainment PC includes three IEEE 1394 ports, with at least one easily accessible connector**
Recommended
- 5.3. **All Entertainment PC input devices meet USB HID specifications**
Recommended
- 5.4. **Entertainment PC includes a remote-control pointing device**
Recommended
- 5.5. **Entertainment PC audio subsystem meets PC 99 audio requirements**
Required
- 5.6. **Graphics subsystem meets Entertainment PC 99 requirements for 3-D acceleration**
Required
- 5.7. **Entertainment PC includes support for television output if the system doesn't have a large-screen monitor**
Recommended

- 5.8. **Entertainment PC includes large-screen DDC2B color entertainment monitor**
Recommended
- 5.9. **Entertainment PC DVD and TV playback meet PC 99 requirements**
Required
- 5.10. **Entertainment PC includes analog video input and capture capabilities**
Recommended
- 5.11. **Entertainment PC includes analog television tuner**
Recommended
- 5.12. **Entertainment PC includes digital broadcast satellite subsystem**
Recommended
- 5.13. **Entertainment PC includes DTV support**
Recommended

Addendum for Mobile PC 99

Technical Clarification: These are new definitions for this section of the Mobile guidelines:

- **Port Replicator:** A port replicator is a module that manages external cable connections. It adds no new features, functionality, or devices. All cable connector receptacles on a port replicator are simple extensions of the wiring for connector receptacles on the back panel of the mobile PC platform. An event notification message should be sent and properly handled when the mobile unit is attached to or detached from the port replicator. The module should have mechanisms to determine attach or detach events that do not require active electronics in the port replicator. For example, a switch in the mobile unit might be activated when the port replicator is mated.
- **Mini-Dock:** A mini-dock can perform the same functions as a port replicator, with one additional feature: a mini-dock incorporates some form of active electronics to create extended mobile PC platform features and functions. The added active electronics might provide additional user-accessible PC Card slots, communication receptacles, or both. These slots and receptacles might be RS-232, IEEE 1284, IEEE 1394, and so on. The mini-dock does not provide user-accessible expansion slots other than CardBus slots, but it might provide internal expansion capabilities accessible only to the OEM.

A mini-dock does not have internal user-upgradeable capabilities for adding desktop peripherals or I/O expansion cards. Therefore, a mini-dock can be considered a sealed docking station, where all expansion capabilities are provided using external expansion ports, so that the operating system always knows what to expect about available devices. However, being sealed does not preclude designs that include internal components that can be upgraded by the OEM or trained service personnel. When such upgrades are done, the mini-dock must employ mechanisms that result in the operating system establishing a new configuration for the mini-dock.

- 6.1. **Mobile PC performance meets Mobile PC 99 minimum requirements**
Required

Technical Clarification for unique system ID (PC99:3.5.1): Only mobile PCs that ship with an integrated network adapter are required to provide the unique system ID in printed form. The initial use of the unique system ID will be for creating a Machine Account Object for the Windows 2000 Remote Installation Services. Currently, no Microsoft operating system supports remote installation using a PC Card network adapter.

- 6.2. **Mobile PC supports Smart Battery or ACPI Control Method battery**
Required

Technical Clarification: Every device in a mobile PC system should function fully on both AC and DC power. It is not acceptable for hardware or system firmware to autonomously disable, remove, or force power down of devices on an AC->DC transition. This can cause situations that result in system hangs, lost data, operating system failure of subsequent power management events, or at the least, warning messages displayed to the user. Internal devices must only be powered down, disabled, or removed when commanded to do so by the operating system and device drivers in accordance with bus and device power management specifications.

This clarification does not require port replicators or docking stations to operate on battery power.

- 6.3. **Expansion capabilities of mobile PC are accessible to users**
Required

- 6.4. **Mobile PC connections use icons plus keyed or shrouded connectors**
Required

- 6.5. **Mobile PC includes one USB port**
Required

- 6.6. **USB-connected device does not maintain fully on power state**
Required

- 6.7. **Mobile PC includes an IEEE 1394 port**
Recommended

- 6.8. **Mobile PC includes CardBus**
Required

- 6.9. **Mobile PC keyboard and pointing device meet PC 99 requirements**
Required

Technical Clarification: The *required* default BIOS option is to provide an option to disable the internal pointing device when any external PS/2-type pointing device is detected at startup. In this case, the driver for the internal pointing device must not load.

- 6.10. **Mobile PC includes IR devices compliant with IrDA specifications**
Recommended

- 6.11. **Mobile PC includes support for installing the operating system**
Required

- 6.12. **Mobile PC includes audio that meets Mobile PC 99 audio requirements**
Recommended
- 6.13. **Mobile PC includes communications device**
Recommended
- 6.14. **Mobile system supports hot-pluggable devices and alternative network connections**
Recommended
- 6.15. **Mobile system meets Mobile Power Guidelines '99**
Recommended
- 6.16. **Mobile system includes CD or DVD drive**
Recommended
- 6.17. **Mobile system meets Manageability Baseline requirements**
Required if Windows 2000 is preinstalled
- 6.18. **Built-in display adapter meets Mobile PC 99 minimum capability**
Required
- 6.19. **Built-in display adapter with 3-D hardware acceleration capabilities meets Mobile PC 99 minimum capability**
Required
- 6.20. **Mobile system meets Mobile PC 99 requirements for supporting multiple adapters and multiple monitors**
Required
- 6.21. **External graphics adapter interface supports DDC monitor detection**
Required

Technical Clarification: Because of the power limitations placed on mobile computers, they are not required to supply +5V power via the external graphics adapter as is currently required by the VESA DDC specification.

Note: Some display devices rely on the +5V to power their DDC circuitry, for Plug and Play detection, or both. It is recommended that a mobile PC provide a means to enable the +5V power when necessary.

- 6.22. **Mobile system with MPEG-2 or DVD playback features meets Mobile PC 99 requirements for video playback**
Required
- 6.23. **Mobile system with AGP supports meets Mobile PC 99 requirements**
Required
- 6.24. **System meets Mobile PC 99 requirements if television output is implemented**
Required
- 6.25. **Built-in mobile display supports ICC color management**
Required
- 6.26. **System supports PCI docking through a bridge connector**
Recommended
- 6.27. **Docked mobile PC supports state change notification using ACPI**
Required

- 6.28. **Docked mobile PC has the ability to identify the specific model of the dock**
Required
- 6.29. **Docked mobile PC has the ability to uniquely identify the dock**
Required
- 6.30. **Mobile PC/docking station combination meets PC 99 requirements**
Required
- 6.31. **Docking station meets all PC 99 system requirements**
Required
- 6.32. **Mobile/docking station interface is supported using ACPI-defined mechanisms**
Required
- 6.33. **Mobile PC/docking station combination supports automatic resource assignment and dynamic disable capabilities**
Required
- 6.34. **Docking station supports warm docking**
Required
- 6.35. **Docking system supports fail-safe docking**
Required
- 6.36. **Docking station includes an IEEE 1394 port**
Recommended
- 6.37. **Docking station/mobile pair meets PC 99 audio requirements**
Recommended

Technical Clarification: It is not required that a mobile/docking station pair implement audio. The requirements listed in item 6.37 apply only if audio is implemented. The following provides a clarification to the requirement:

The user must be able to select speakers in the mobile unit or the docking station. System vendors can choose to automate the process either in the docking station or the mobile PC to meet this requirement. For example, instead of offering a UI where the user can select speakers, the system manufacturer can configure the pair to automatically turn on the docking station speakers and turn off the mobile PC speakers when in the docked configuration.

The objective of this requirement is to ensure that users can access the highest quality audio output in any given configuration. If speakers are selected automatically, the vendor should prevent multiple outputs from occurring simultaneously. If speakers are not automatically selected, then a manual selection process must be offered to the user. Additionally, the speakers should be switched off if the headphone or line-out jacks are used.

- 6.38. **Mini-dock supports automatic resource assignment and dynamic disable capabilities for replacement devices**
Required
- 6.39. **Mini-dock supports warm docking**
Required
- 6.40. **Mini-dock supports fail-safe docking**
Required

- 6.41. **Mini-dock includes an IEEE 1394 port**
Recommended
- 6.42. **Mini-notebook performance meets PC 99 minimum requirements**
Required

Addendum for USB

- 7.1. **System includes USB with two USB ports, minimum**
Required for all system types, with exceptions for mobile PCs
- 7.2. **Systems include BIOS support for USB keyboards and hubs**
Required
- 7.3. **All USB hardware complies with USB 1.0 specification**
Required
- 7.4. **Connections use USB icon**
Required
- 7.5. **Devices and drivers support maximum flexibility of hardware interface options**
Required
- 7.6. **USB host controller meets either OpenHCI or UHCI specification**
Required
- 7.7. **USB host controller can wake the system**
Required
- 7.8. **USB hubs comply with USB 1.1 specification**
Recommended
- 7.9. **Bus-powered USB hubs provide ports that can be individually power switched**
Recommended
- 7.10. **Systems and devices comply with USB power management requirements**
Required
- 7.11. **USB devices meet requirements in related USB device class specification**
Required

Addendum for IEEE 1394

- 8.1. **Controllers and devices support mandatory features in IEEE P1394a-1999 with backward compatibility with IEEE 1394-1995**
Required

Technical Correction: The reference to IEEE 1212-199x should instead be IEEE P1212r, which more properly reflects support implemented in Windows 98 and Windows 2000.
- 8.2. **Controllers comply with OpenHCI for IEEE 1394**
Required

Technical Correction: The specification citation should be "IEEE 1394 OpenHCI, Revision 1.0 or later." Compliance with OpenHCI v.1.1 (when this version is available) is acceptable under Windows 98 and Windows 2000.

Also, the final paragraph in this requirement should be replaced with the following text: Only computers running Windows 98, Windows 2000, or later versions of these operating systems are required to implement an OpenHCI-compliant Link.”

8.3. OpenHCI controllers and devices support advances defined in IEEE P1394a-1999
Required

8.4. Host supports peak data rate of 400 Mb/s, minimum
Required

8.5. Design avoids excessive currents resulting from ground-fault potential among devices
Recommended

Technical Correction: The entire text for this recommendation should be replaced with the following: Devices should meet appropriate local regulatory approval (for

8.6. Device command protocols conform to standard device class interfaces
Required

Technical Correction: IEEE 1394 devices must comply with appropriate industry-recognized transport and command standards, such as the following:

- IEC 61883 parts 1-6, including CIP (Common Isochronous Packet) headers, CMP (Connection management Procedures), and FCP (Function Command Protocol)
- 1394TA AV/C 3.0 and the AV/C subunit family of specifications
- National Committee for Information Technology Standards (NCITS) SBP-2 transport protocols
- National Committee for Information Technology Standards (NCITS) T10, Reduced Block Commands (RBC)
- National Committee for Information Technology Standards (NCITS) T10 MMC-2, or SFF 8090, Version 3

Technical Clarifications:

- Storage class devices must conform to the ANSI standards for SBP-2 (Serial Bus Protocol) with the appropriate command set: RBC (Reduced Block Commands) or MMC-2 (MultiMedia Commands).
- Printing devices using the SBP2 protocol must conform to the guidelines set in SBP-2 Support and Windows 2000, available at http://www.microsoft.com/hwdev/print/sbp2_w2000.htm.
- Drivers for IEEE 1394 must take advantage of WDM-based driver support provided in the operating system.

8.7. Devices support peak data rate of 400 Mb/s, minimum
Required

Technical Clarification: Delete the paragraph that begins ‘Also, application bandwidth can be limited by speed traps...’

- 8.8. **Devices requiring support for high-bandwidth data transfer use IEEE 1394**
Recommended
- 8.9. **Plug and Play devices demonstrate interoperability with other devices**
Required
- Errata:** The correct URL for the Plug and Play guidelines is <http://www.microsoft.com/hwdev/respec/pnpspecs.htm>. This specification was updated on March 2, 1999 (version 1.0c) to present the correct implementation under the Windows 2000 operating system, which also closely reflects the requirements in the IEEE 1394 standard.
- 8.10. **Topology faults do not cause the bus to fail**
Required
- Technical Correction:** Delete the 3rd and 4th bullet items (Greater than 16 hops' and Greater than 63 devices on a local IEEE 1394 bus), because these capabilities are not under the control of devices. These design issues must be addressed instead through revisions of the IEEE standard.
- 8.11. **Removable media devices support media status notification**
Required
- See the clarifications at item 18.2.
- 8.12. **Devices that can initiate peer-to-peer communications also support remote programming**
Required
- 8.13. **Device provides a configuration ROM for unique device identification**
Required
- 8.14. **Device configuration ROM implements general ROM format**
Required
- 8.15. **Bus information block implemented at a base address offset of 0404h**
Required
- 8.16. **Configuration ROM provides globally unique device ID**
Required
- 8.17. **Root directory is located at a fixed address following the bus information block**
Required
- 8.18. **Configuration ROM includes a unit directory for each independent device function**
Required
- 8.19. **Each unit directory provides a valid Unit_Spec_Id and Unit_Sw_Version**
Required
- 8.20. **Each unit directory provides a pointer to a unit-dependent directory**
Required
- 8.21. **Vendor and model leaves support textual descriptor leaf format**
Required
- 8.22. **Unit-dependent directory provides a pointer to the unit's CSRs**
Required
- 8.23. **Device provides more than one connector port**
Recommended

- 8.24. Device uses the approved IEEE 1394 connectors**
Required
- 8.25. Self-powered devices propagate the power bus through each connector**
Required
- 8.26. Only single-port leaf-node devices use 4-pin connectors**
Required
- 8.27. Device connectors exhibit common speed and power characteristics**
Required
- 8.28. Standard S400-rated IEEE 1394 cable is provided with devices**
Required
- 8.29. Devices provide sufficient power to their PHY at appropriate times**
Required
- 8.30. Devices report power source and cable power consumption in Self_id packet**
Deleted
- Technical Correction:** This is no longer a PC 99 requirement, because this is a function of the IEEE standard.
- 8.31. Devices implement link power control**
Required
- 8.32. Device requiring power increments in excess of Link_on implements unit-power CSRs**
Required
- 8.33. Devices that source cable power report this capability**
Required
- 8.34. IEEE 1394-enabled PC sources cable power compliant with IEEE 1394a-1999**
Required
- Technical Correction:** Note title change.
- 8.35. Power source supplies appropriate cable power**
Deleted
- Technical Correction:** This is not a PC 99 requirement. Changes to PC99:8.34 eliminate this clause.
- 8.36. Devices notify the power manager of power change requests**
Deleted
- Technical Correction:** This is not a PC 99 requirement. There is no defined way for this to occur in the PC 99 timeframe. The Power State and Power Distribution Specifications have not been published.
- 8.37. Devices and controllers comply with the 1394 Trade Association Power Specification, Part 1: Cable Power Distribution, Rev. 0.98**
Required
- Technical Correction:** The correct specification is *1394 Trade Association Power Specification, Part 1: Cable Power Distribution, Rev. 0.98*.
- 8.38. Devices and controllers comply with IEEE 1394 power specification**
Deleted

Technical Correction: This is not a PC 99 requirement. This specification does not yet exist. An early revision of the specification will be *1394 Trade Association Power Specification, Part 3: Power State Management, Rev. 1.0*. It is believed that this specification will be published and adopted in October 1999. The IEEE standard version of this specification will be available for PC 2001, but not for PC 99.

Addendum for PCI

9.1. All components comply with PCI 2.1
Required

Note: The PCI SIG has released v2.2 of the *PCI Local Bus Standard Specification*. See <http://www.pcisig.com> for information. PCI 2.2 is expected to become a requirement in the next version of the PC design guide.

Technical Clarification: The system BIOS must correctly configure PCI-to-PCI bridges if the system has a VGA device behind a bridge. Specifically, the BIOS must correctly set the VGA Enable and ISA Enable bits on the bridges, to avoid causing the bridges to be in conflict with each other.

Additional details with illustrated examples of correct configurations of PCI-to-PCI Bridge devices are provided in the white paper titled *Configuring PCI-to-PCI Bridges with VGA Cards* at <http://www.microsoft.com/hwdev/pci/vgacard.htm>.

9.2. System does not contain ghost devices
Required

9.3. System uses standard method to close BAR windows on nonsubtractive decode PCI bridges
Required

9.4. System provides 3.3 V to all PCI connectors
Required

9.5. PCI add-on devices support both 5 V and 3.3 V signaling
Recommended

9.6. System-board bus complies with PCI 2.1
Required

9.7. Bus master privileges are supported for all connectors
Required

9.8. Functions in a multifunction PCI device do not share writable PCI Configuration Space bits
Required

9.9. All PCI devices complete memory write transaction (as a target) within specified times
Required

9.10. Devices use PCI 2.1 Configuration Space for Plug and Play device ID
Required

9.11. Device IDs include Subsystem IDs
Required

Technical Clarification: The Subsystem ID (SID) and Subsystem Vendor ID (SVID) fields are required to comply with the Subsystem ID ECN to PCI 2.1 or the equivalent

requirement in PCI 2.2. For guidelines to the required implementation of the PCI device SID and SVID registers, see the white paper *PCI Device Subsystem IDs for Windows*, available at <http://www.microsoft.com/hwdev/devdes/pciids.htm>.

Technical Clarification: For subsystems on system boards that contain a PCI device, the SVID and SID registers must also be loaded with valid non-zero values before the operating system accesses the device. The subsystem exceptions to this requirement are certain sub-classes of bridges and core chipset components, which are specified in section 6.2.4 and Appendix D of the *PCI 2.2 Local Bus Specification*. The PCI 2.2 specification became the industry standard on December 18, 1998. For the convenience of the reader, the excepted sub-classes of bridges (PCI base class 6) and core chip set components (PCI base class 8) are listed here, but for full information the reader must refer to the PCI 2.2 specification:

- Bridges (PCI base class 6)
 - Host bridge (Sub-class 0)
 - ISA bridge (Sub-class 1)
 - EISA bridge (Sub-class 2)
 - MCA bridge (Sub-class 3)
 - PCI-to-PCI bridge and Subtractive Decode PCI-to-PCI bridge (Sub-class 4)
- Core chip set components (PCI base class 8)
 - Generic 8259, ISA, EISA, and I/O APIC programmable interrupt controllers (Sub-class 0)
 - Generic 8237, ISA, and EISA DMA controllers (Sub-class 1)
 - Generic 8254, ISA, and EISA system timers (Sub-class 2)
 - Generic and ISA RTC controllers (Sub-class 3)

Technical Clarification: Audio/modem riser (AMR) devices and modem riser (MR) devices on the motherboard are *not* exempt from the requirement for SID and SVID.

- 9.12. **Configuration Space is correctly populated**
Required
- 9.13. **Interrupt routing is supported using ACPI**
Required
- 9.14. **BIOS does not configure I/O systems to share PCI interrupts**
Recommended
- 9.15. **BIOS configures boot device IRQ and writes to the interrupt line register**
Required
- 9.16. **Systems that support hot plugging for any PCI device use ACPI-based methods**
Required
- 9.17. **All PCI components comply with PCI Bus Power Management Interface specification**
Required

Technical Clarification: *PCI Bus Power Management Interface Specification, Revision 1.1* or later, is the only industry specification that ensures compatibility with the power management capabilities of Windows 2000, which uses PME# as the wake-up signal.

Technical Clarification: The PCI bus, any PCI-to-PCI bridges on the bus, and all add-on capable devices on the PCI bus must comply with the *PCI Bus Power Management Interface Specification, Revision 1.1* or later, whether or not the system they are installed in provides 3.3Vaux to its PCI connectors.

A method that PCI add-on cards can use to meet this requirement is described in Section 7.4.4 of the *PCI Bus Power Management Interface Specification*: Static FET switches on the add-on card re-route 3.3VPCI, or converted 5VPCI, to the 3.3Vaux power plane when the card is installed in a system that does not supply 3.3Vaux. However, the added cost of these static FET switches is not justified for PCI add-on cards installed exclusively in OEM systems.

On OEM systems that supply 3.3Vaux, the OEM-version PCI add-on card's split Vaux power plane is tied directly to the 3.3Vaux pin on the system PCI connector. For systems that do not deliver 3.3Vaux, the OEM-version PCI add-on card's Vaux power plane is tied directly to the required 3.3VPCI source.

PC add-on cards designed and built exclusively for installation in OEM systems and which are never sold through retail distribution channels are not required to supply the static FET switches described in section 7.4.4 of the *PCI Bus Power Management Specification*.

This PC 99 requirement includes correct implementation of the PCI Configuration Space registers used by power management operations, and the appropriate device state (Dx) definitions.

ACPI is not an acceptable alternative for PC 99.

Technical Clarification: Functions (for example, PCI-to-PCI bridges, USB host controllers, IDE controllers, and so on) that are integrated as part of the core chipset, and thus not add-on capable devices, can use ACPI (and not PCI Power Management registers) for their power management interface.

9.18. System provide support for 3.3Vaux if a system supports S3 or S4 states
Required

Note: For more information about the related hardware implementation, see clarification on the PCI specification, 3.3Vaux power delivery/consumption requirements FAQ published by the PCI Special Interest Group (PCI SIG), available at <http://developer.intel.com/technology/iapc/pc99vqa.htm>.

9.19. Bus power states are correctly implemented
Required

9.20. PCI-based modem and network adapters support wake-up
Required

Addendum for ATA and ATAPI

- 10.1. **Controller and peripherals comply with ATA-2, ATA-3, or ATA/ATAPI-4 standards**
Required
- 10.2. **Bootable ATA controller supports El Torito No Emulation mode**
Required
- 10.3. **Option ROMs support Int 13h Extensions**
Required

Technical Clarification: This requirement also applies for RAID controllers implemented on client systems such as workstations.

The Int 13h Extensions are defined in Chapter 14: 'Int 13 Extension APIs' in the 'Storage Technology Reference' in the Windows 95 DDK (included with the Windows 98 DDK and available online at http://www.microsoft.com/ddk/ddkdocs/win98ddk/storage_60q9.htm).

- 10.4. **Dual ATA adapters use single FIFO with Asynchronous access or dual FIFOs and channels**
Required
- 10.5. **System BIOS and devices support LBA**
Required
- 10.6. **System BIOS supports ARMD**
Recommended
- 10.7. **Controller and peripherals support Ultra DMA**
Required

Technical Correction: ATA and ATAPI devices must meet the following support requirements and recommendations for Ultra DMA and IDE Bus Master DMA.

Support for Ultra DMA:

- Required for ATA controllers and ATA devices
- Recommended for ATAPI peripherals

However, ATAPI devices might be connected to the ATA bus (which is required to support UDMA). Therefore, to ensure that ATAPI devices will tolerate Ultra DMA, ATAPI devices must support the termination scheme as defined in ATA/ATAPI-4 or SFF 8038i.

Support for IDE Bus Master DMA:

- Required for ATA controllers
- Required for ATA devices and ATAPI peripherals, including CD and DVD devices
- Recommended for ATA/ATAPI tape drives
- Recommended for ATAPI removable media drives

- 10.8. **Controller and peripheral connections include Pin 1 cable designation with keyed and shrouded connectors**
Required
- 10.9. **Peripherals comply with ATA/ATAPI-4 or SFF 8020i v.2.5**
Required
- 10.10. **Removable media devices support media status notification**
Required

See the clarifications at item 18.2.
- 10.11. **BIOS enumeration of all ATAPI devices complies with ATA/ATAPI-4 or SFF 8020i v.2.5**
Required
- 10.12. **ATAPI devices support DEVICE RESET command**
Required
- 10.13. **Each device has a Plug and Play device ID**
Required
- 10.14. **Dynamic resource configuration is supported for all devices**
Required
- 10.15. **Resource configuration meets bus requirements**
Required
- 10.16. **ISA address ranges 3F7h and 377h are not claimed by ATA controllers**
Required
- 10.17. **Bus and device meet PC 99 power management requirements**
Required
- 10.18. **ATA device supports ATA STANDBY command**
Required

Addendum for SCSI

- 11.1. **SCSI host controller supports bus mastering**
Required
- 11.2. **Bootable SCSI controller supports El Torito No Emulation mode**
Required
- 11.3. **Option ROM supports Int 13h Extensions**
Required

Technical Clarification: This requirement also applies for RAID controllers implemented on client systems such as workstations.

The Int 13h Extensions are defined in Chapter 14: Int 13 Extension APIs in the Storage Technology Reference in the Windows 95 DDK (included with the Windows 98 DDK and available online at http://www.microsoft.com/ddk/ddkdocs/win98ddk/storage_60q9.htm).

- 11.4. **Option ROM supports virtual DMA services**
Required

- 11.5. **Bus type is clearly indicated on connectors for all adapters, peripherals, cables, and terminators**
Required
- 11.6. **Differential devices support DIFFSENS as defined in SPI standard**
Required
- 11.7. **Automatic termination circuit and SCSI terminators meet SCSI-3 standard**
Required
- 11.8. **Terminator power is supplied to the SCSI bus with overcurrent protection**
Required
- 11.9. **External connector meets SCSI-2 or later standard**
Required
- 11.10. **Controller and peripherals implement SCSI bus data protection signal**
Required
- 11.11. **SCSI connections use keyed and shrouded connectors**
Required
- 11.12. **External devices use automatic termination or an accessible on-board termination switch**
Required
- 11.13. **Shielded device connector meets SCSI-2 or later standard**
Required
- 11.14. **Removable media devices support media status notification**
Required

See the clarifications at item 18.2.
- 11.15. **Each device has a Plug and Play device ID**
Required
- 11.16. **Dynamic resource configuration is supported for all devices**
Required
- 11.17. **Resource configuration meets bus requirements**
Required
- 11.18. **SCAM support is disabled by default**
Required
- 11.19. **SCSI devices that support hot-plugging meet PC 99 requirements**
Required
- 11.20. **SCSI controllers provide multi-initiator support**
Recommended
- 11.21. **Bus and device meet PC 99 power management requirements**
Required
- 11.22. **Hardware supports the STOP/START UNIT command as defined in the SPI standard**
Required
- 11.23. **STOP/START UNIT command is used to decrease power consumption**
Required

Addendum for PC Card

12.1. All devices comply with the PC Card standards

Required

Note: For information about implementing R2 version cards to use only 3.3 volts, see the white paper titled *PC Card Voltage Requirements and the Windows Operating System* at <http://www.microsoft.com/hwdev/cardbus/pccardvlt.htm>.

12.2. System and ZV-compatible 16-bit PC Cards comply with ZV standard definitions

Required

12.3. Controller supports industry-standard ExCA register set

Required

12.4. System maintains mapping of IRQ Routing Register bits to system interrupt vectors

Required

12.5. IRQ connections can be determined by using the 0805 register

Required

12.6. CardBus controllers support both ISA and PCI interrupts

Required

Technical Clarification: To ensure that the Windows operating system can correctly assign ISA IRQs to 16-bit PC Cards, CardBus controllers that have parallel ISA IRQ mode must have all ISA IRQ pins, except IRQ 0 (timer), 1 (keyboard), 6 (floppy), 8 (CMOS), 13 (math coprocessor). It is recommended that system vendors using parallel ISA IRQ mode always connect ISA IRQs 3, 4, 5, 7, 9, 10, 11, 12, 14, 15 and not cross wire them.

For vendors using serialized IRQ mode, the above is irrelevant because they only need to connect the serial IRQ pin, and the ISA IRQ information will be sent to the PCI chip set serially; the ISA IRQ information can specify any of IRQ 0-15.

12.7. System supports industry-standard definition for CardBus bridges

Required

12.8. BIOS initializes CardBus controller in 82365-compatible mode and supports backward compatibility

Recommended

12.9. CardBus controllers do not share writable PCI Configuration Space bits

Required

12.10. Each 16-bit PC Card memory window in CardBus controller has its own page register

Required

12.11. Card supports required I/O card tuples

Required

12.12. Configuration table entry tuples listed in priority order

Required

12.13. Card specifies maximum configuration options

Required

12.14. Configuration Space meets Common Silicon Guidelines

Required

- 12.15. **RESERVED fields comply with PCI 2.1**
Required
- 12.16. **CardBus card implements required and recommended tuples**
Required
- 12.17. **Socket controller complies with device class power management reference specification**
Required
- 12.18. **16-bit PC Card cards implement power-related events using ReqAttn bit and #STSCHG mechanism**
Required
- 12.19. **CardBus controllers and cards implement PCI power management specifications**
Required

Technical Clarification: CardBus cards (which are by definition PCI devices) must comply with *PCI Bus Power Management Interface Specification, Revision 1.1* or later, in order for power management to be implemented properly under Windows 2000, which uses PME# as the wake-up signal. This is the only industry specification that ensures compatibility with the power management capabilities of Windows 2000.

Note that power management requirements for 16-bit PC Card cards are defined separately in item 12.18.

- 12.20. **No user intervention required for correctly installing devices**
Required
- 12.21. **Device is immediately functional without restarting the system**
Required
- 12.22. **ZV-compatible PC Card driver uses DirectDraw LVE**
Required
- 12.23. **16-bit PC Card card driver supports sharing of level-mode interrupts**
Required

Addendum for I/O Ports and Devices

| | Consumer | Office | Mobile | Workstation | Entertainment |
|-------|--|--------|--------|-------------|---------------|
| 13.1. | System includes connection for external serial devices <i>Required for all system types</i> | | | | |
| 13.2. | System includes connection for external parallel devices <i>Required for all system types</i> | | | | |
| 13.3. | System includes external connection for keyboard <i>Required for all system types</i> | | | | |
| 13.4. | System includes pointing-device connection and pointing device <i>Required for all system types</i> | | | | |
| 13.5. | System includes USB game pad or joystick <i>Required for all system types; wireless recommended for Entertainment PC</i> | | | | |

Errata: The requirement is meant to state that if a game pad or joystick is included in a PC system, it should be implemented using USB. It is *not* required to include any such devices on a system.

Note: No devices that use legacy or proprietary ports can be included in a PC system.

- 13.6. **System includes built-in wireless capabilities**
Recommended for all system types
 - 13.7. **Devices use USB or external bus connections rather than legacy serial or parallel ports**
Required Recommended Recommended Required Required
 - 13.8. **All devices meet PC 99 general device requirements**
Required
 - 13.9. **Serial port meets device class specifications for its bus**
Required
 - 13.10. **Legacy serial port is implemented as 16550A UART or equivalent and supports 115.2K bps**
Required
 - 13.11. **Legacy serial port supports dynamic resource configuration**
Required
- Technical Clarification:** For information about how the system determines the correct peripheral device driver, see Device Installation Functions in the Windows 98 DDK and the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win98ddk/devinst_12uw.htm and http://www.microsoft.com/ddk/ddkdocs/Win2k/di-rtns_85ma.htm, respectively).
- 13.12. **Conflict resolution for legacy serial port ensures availability of at least one serial port**
Required
 - 13.13. **Parallel port meets device class specifications for its bus**
Required
 - 13.14. **Flexible resource configuration supported for each parallel port**
Required
 - 13.15. **EPP support does not use restricted I/O addresses**
Required
 - 13.16. **Compatibility, nibble mode, and ECP protocols meet IEEE 1284-1994 specifications**
Required
 - 13.17. **Port connectors meet IEEE 1284-I specifications, minimum**
Required
 - 13.18. **IEEE 1284 peripherals have Plug and Play device IDs**
Required
 - 13.19. **Device identification string provides a Compatible ID key**
Recommended
 - 13.20. **Daisy-chained parallel port device is Plug and Play capable**
Required
 - 13.21. **Pointing-device connection meets requirements for its bus class**
Required

Technical Clarification: For information about implementing minidriver support based on WDM Human Interface Device (HID) class support in the operating system, see Chapter 1 I/O Requests for HID Minidrivers in the Windows 2000 DDK, which defines the implementation for both Windows 98 and Windows 2000 (online at http://www.microsoft.com/ddk/ddkdocs/Win2k/hidioreq_92k2.htm).

13.22. Remote control pointing device provides PC 99 minimum support
Recommended

13.23. Keyboard connection meets requirements for its bus class
Required

13.24. No interference occurs between multiple keyboards
Required

13.25. Keyboard includes Windows and Application logo keys
Recommended

The correct listing of all keyboard scan codes for Windows operating systems is being made available at <http://www.pcdesguide.org/documents/keycode.htm>. This online listing replaces the previous reference to *New Key Support for Microsoft Windows Operating Systems and Applications*.

13.26. Device meets USB HID class specification requirements
Required

13.27. IR device uses NDIS 5.0 miniport driver
Required

Technical Clarification: For documentation and sample source code for building a miniport driver, see Chapter 10 IrDA Miniport NIC Drivers in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2k/210irda_8fdz.htm).

13.28. IR device meets IrDA specifications
Required

13.29. IR device meets PC 99 bus and port specifications
Required

13.30. IR device supports dynamic resource configuration
Required

13.31. IR device meets USB guidelines for interfacing with IrDA Data and IrDA Control devices
Required

13.32. System supports standard input speeds of 4 Mb/s
Required

13.33. System provides a separate, physically-isolated transceiver for each IR protocol supported
Required

13.34. System supports RF capabilities
Optional

13.35. RF implementation uses a low-power RF alternative
Recommended

13.36. RF implementation provides a method to defeat noise and conflict with other RF devices
Recommended

- 13.37. System and RF device have separate local certification**
Recommended
- 13.38. Smart card reader complies with ISO 7816**
Required
- 13.39. Smart card reader supports ISO 7816 T=0 and T=1 protocols**
Required
- 13.40. Smart card reader supports inverse-convention smart cards**
Required
- 13.41. Smart card reader supports 258 byte packets in T=0 and 259 byte packets in T=1**
Required
- 13.42. Smart card reader supports a smart card insertion/removal monitor**
Required
- 13.43. Smart card reader supports PTS**
Required
- Technical Correction:** The correct citation for the specification is ISO 7816-3 (1997-12-15) Section 7.
- 13.44. Smart card reader supports 3.5795 MHz minimum clock frequency**
Required
- 13.45. Smart card reader supports 9600 bps minimum data rate**
Required
- 13.46. Smart card reader supports the Power Down command**
Required
- Technical Correction:** The correct citation for the specification is ISO 7816-3 (1997-12-15) Section 5.4.
- 13.47. Smart card reader does not use an additional power supply**
Recommended
- 13.48. Each device has a unique Plug and Play device ID**
Required
- 13.49. Dynamic resource configuration is supported for all devices**
Required
- 13.50. Each device complies with its device class power management reference specification**
Required
- 13.51. Device supports wake-up events**
Required for wireless input; optional for other devices
- 13.52. Device drivers and installation meet PC 99 requirements**
Required
- 13.53. All PC 99 input devices support Microsoft DirectInput and work simultaneously**
Required

Technical Clarification: For information about implementing drivers that support simultaneous use of devices, see the Microsoft DirectInput DDK, which is provided with the Windows 98 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win98ddk/di_ddk_9rxw.htm).

Addendum for Graphics Adapters

| | Consumer | Office | Mobile | Workstation | Entertainment |
|--------|--|--------|--------|-------------|---------------|
| 14.1. | Graphics adapter uses PCI, AGP, or another high-speed bus <i>Required for all system types</i> | | | | |
| 14.2. | System provides hardware-accelerated 3-D graphics <i>Required Recommended Recommended Required Required</i> | | | | |
| | Technical Clarification: For implementation details for OpenGL driver support, see Chapter 5 Mini Client Driver in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2k/mcd_74x3.htm). | | | | |
| 14.3. | System uses WC with higher-performance processors <i>Required for all system types</i> | | | | |
| 14.4. | Primary graphics adapter works normally with default VGA mode driver <i>Required for all system types</i> | | | | |
| | Technical Clarification: For information about supporting VGA mode, see Display Drivers in the Windows 98 DDK and Part 2 Display and Video Miniport Drivers in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win98ddk/display_1ca9.htm and http://www.microsoft.com/ddk/ddkdocs/Win2k/vidintro_9j8n.htm , respectively). | | | | |
| 14.5. | Adapter and driver support multiple adapters and multiple monitors <i>Required Required Recommended Required Required</i> | | | | |
| 14.6. | Adapter supports television output if system does not include large-screen monitor <i>Recommended for all system types</i> | | | | |
| 14.7. | Adapter meets PC 99 general device requirements <i>Required for all system types</i> | | | | |
| 14.8. | Screen resolution and local memory capacity meet PC 99 minimum requirements <i>Required for all system types, with exceptions for mobile PCs</i> | | | | |
| 14.9. | Adapter meets VESA specifications for ergonomic timing rates <i>Required for all system types, with exceptions for mobile PCs and flat panel desktop displays</i> | | | | |
| 14.10. | All supported color depths are enumerated <i>Required for all system types</i> | | | | |
| 14.11. | Graphics operations use relocatable registers only <i>Required for all system types</i> | | | | |
| 14.12. | Adapter supports downloadable RAMDAC entries for integrated color management <i>Required for all system types</i> | | | | |
| 14.13. | Adapter supports DDC monitor detection <i>Required for all system types, with exceptions for mobile PCs</i> | | | | |
| 14.14. | Hardware supports video overlay surface with scaling <i>Required for systems that support TV or DVD video playback, with exceptions for mobile PCs</i> | | | | |
| | Technical Correction to 14.14.4: The ability to shrink and zoom by a variable factor of up to 8:1 in one-pixel increments is required; the ability to shrink by a variable factor of up to 16:1 in one-pixel increments is recommended. (All other requirements, | | | | |

exceptions, and so on are the same as originally defined in *PC 99 System Design Guide*.)

- 14.15. Hardware supports VGA destination color keying for video rectangle**
Required for systems that support TV or DVD video playback

Technical Correction: The example for a specific color/color range includes 8-bit, 15-bit, and 24-bit SVGA modes (4-bit mode is not required).

- 14.16. Hardware supports alpha blending of graphics and video**
Required for systems that support TV or DVD video playback, with exceptions for mobile PCs and Office PCs

- 14.17. Video port meets PC 99 specifications if present on graphics adapter**
Required

Technical Clarification: For information about implementing driver support, see the 'Video Port Extensions to DirectX' topics in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2k/ddraw_7ehz.htm).

- 14.18. Hardware supports MPEG-2 motion compensation acceleration**
Recommended

- 14.19. Hardware supports scanning at the same frequency as the incoming video**
Recommended Recommended Recommended Recommended Required

Technical Clarification: For technical details about implementing driver support for multiple adapters and multiple monitors, see 'Multiple Monitor Support Implementation Design Notes' in the Windows Support in the Display Driver' in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win98ddk/multimon_0wmmr.htm and http://www.microsoft.com/ddk/ddkdocs/Win2k/vidintro_9c87.htm, respectively).

- 14.20. Extended resources can be dynamically relocated after system boot**
Required

- 14.21. VGA resources can be disabled by software**
Required

- 14.22. Frame buffer can be accessed directly by applications**
Required for all system types

- 14.23. Adapter and driver support linear-mapped, low-resolution modes**
Required for all system types

- 14.24. Hardware supports transparent blter**
Required for all system types

- 14.25. Hardware provides support to prevent tearing**
Required for all system types

- 14.26. Hardware supports programmable blter stride**
Required for all system types

- 14.27. Hardware supports PC 99-required RGB rasterization**
Required for all system types, with exceptions for mobile PCs

Errata: The text for Alpha blending should state:

14.27.3 Alpha blending. Source alpha blending is required and destination alpha blending is recommended (see item 14.32).

The supporting text remains the same.

- | | | | | | |
|---------------|---|--|--|--|--|
| 14.28. | Hardware supports recommended RGB rasterization features <i>Recommended for all system types, with exceptions for mobile PCs</i> | | | | |
| 14.29. | Hardware supports multi-texturing <i>Recommended Recommended Recommended Required Required</i> | | | | |
| 14.30. | Hardware supports texture formats <i>Required for all system types, with exceptions for mobile PCs</i> | | | | |
| 14.31. | Hardware complies with texture size limitations <i>Required Recommended Recommended Required Required</i> | | | | |
| 14.32. | Hardware supports destination RGB alpha blending <i>Recommended for all system types</i> | | | | |
| 14.33. | Hardware supports Z comparison modes and Direct3D-compatible formats <i>Recommended Recommended Recommended Required Required</i> | | | | |
| 14.34. | Hardware meets PC 99 3-D accelerator performance requirements <i>Recommended Recommended Recommended Required Required</i> | | | | |
| 14.35. | Adapter supports both NTSC and PAL output <i>Recommended for all system types</i> | | | | |
| 14.36. | Default boot mode supports appropriate locale <i>Required for all system types</i> | | | | |
| 14.37. | Adapter supports underscan scaling <i>Required Recommended Recommended Recommended Required</i> | | | | |
| 14.38. | Adapter supports flicker filter <i>Required for all system types, with exceptions for mobile PCs</i> | | | | |
| 14.39. | Adapter provides proper termination <i>Required</i> | | | | |
| 14.40. | Adapter supports composite video and S-Video connectors <i>Recommended Recommended Recommended Recommended Required</i> | | | | |
| 14.41. | Adapter with television output supports both VGA and television output <i>Required for all system types</i> | | | | |
| 14.42. | Software supports positioning <i>Required Recommended Recommended Recommended Required</i> | | | | |
| 14.43. | Software supports detection of television connection <i>Required Recommended Recommended Recommended Required</i> | | | | |
| 14.44. | Analog video outputs, such as NTSC, have copy protection on DVD-enabled platforms <i>Required for all system types</i> | | | | |
| 14.45. | Each device has a Plug and Play device ID <i>Required</i> | | | | |
| 14.46. | System supports conflict resolution, VGA compatibility, and extended registers <i>Required</i> | | | | |

- 14.47. Chips support linear packed-pixel frame buffer, relocatable above 16 MB**
Required
- 14.48. Option ROM supports DDC2B**
Required, with exceptions for Mobile PCs
- 14.49. BIOS setup utility provides option to force use of system-board graphics**
Recommended
- 14.50. BIOS supports large frame buffers for graphics adapters**
Required
- 14.51. AGP meets PC 99 implementation guidelines**
Required
- 14.52. PCI graphics device supports IRQ and correctly populates PCI BARs**
Required Recommended Recommended Required Required
- 14.53. PCI system-board graphics device is not hidden from Plug and Play enumeration**
Required for all system types
- 14.54. Graphics adapter complies with device class power management reference specification**
Required
- 14.55. Graphics adapter complies with VBE/Core 2.0 extensions for power management**
Required
- 14.56. Device drivers and installation meet PC 99 requirements**
Required
- Technical Clarification:** Software provided with graphics adapters designed for use with Windows 2000 must comply with the requirements defined in the Graphics Driver Design Guide² section of the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2k/ggintro_3713.htm).
- 14.57. Driver does not bypass any Microsoft-provided system components**
Required
- 14.58. Applications provided with device meet requirements for Win32-based applications**
Required
- 14.59. Driver supports dynamic color bit-depth change**
Required

Addendum for Video and Broadcast Components

| | Consumer | Office | Mobile | Workstation | Entertainment |
|--|----------|--------|--------|-------------|---------------|
| 15.1. System meets PC 99 requirements for playback of MPEG-2 video from DVD-Video Required for all systems that support TV or DVD video playback | | | | | |
| 15.2. System meets PC 99 requirements for playback of MPEG-2 video from digital TV broadcasts Recommended Recommended Recommended Recommended Required | | | | | |
| 15.3. System supports PC 99 analog video input and capture capabilities Recommended for all system types | | | | | |
| Technical Clarification: All video input sources and capture devices must implement driver support as defined for WDM Stream class in Kernel Streaming Drivers Design | | | | | |

Guide”in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2k/ks-overview_4svn.htm).

- 15.4. **System includes analog TV tuner**
Recommended for all system types
 - 15.5. **System includes digital satellite receiver module**
Recommended for all system types
 - 15.6. **System includes digital cable receiver module**
Recommended for all system types
 - 15.7. **System includes ATSC DTV support**
Recommended for all system types
 - 15.8. **System includes DVB cable, satellite, or terrestrial receiver module**
Recommended for all system types
 - 15.9. **System includes support for multiple digital TV delivery methods**
Recommended for all system types
 - 15.10. **System supports DV decoding and encoding**
Recommended for all system types
 - 15.11. **MPEG sources such as DVD or a receiver module support bus mastering**
Required for all system types, with exceptions for mobile PCs
 - 15.12. **Separate MPEG-2 hardware decoder for high-definition video does not cause PCI bus contention**
Required
 - 15.13. **PCI-based sources of uncompressed standard-definition digital video support bus mastering with scatter/gather DMA**
Required
- Technical Clarification:** For information about implementing driver support, see the “Video Port Extensions to DirectX” topics in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2k/ddraw_7ehz.htm).
- 15.14. **All MPEG-2 decoders can accept an MPEG-2 elementary stream**
Required
 - 15.15. **All MPEG transport stream information is available to the central host processor**
Required
 - 15.16. **Background tasks do not interfere with MPEG-2 playback**
Required Recommended Recommended Required Required
 - 15.17. **Video input, capture, and broadcast device support is based on DirectX foundation class and WDM Stream class**
Required
 - 15.18. **All components meet PC 99 general device requirements**
Required
 - 15.19. **MPEG-2 MP@ML playback meets PC 99 requirements**
Required for all systems that support TV or DVD video playback, with exceptions for mobile PCs
 - 15.20. **MPEG-2 playback for ATSC, DVB, or other digital TV systems meets PC 99 requirements**
Recommended Recommended Recommended Recommended Required

15.21. MPEG-2 video decode implementations meet PC 99 quality requirements*Required for all systems that support TV or DVD video playback, with exceptions for mobile PCs*

Technical Clarification: The Joe Kane Video Essentials disk with the Snell and Wilcox Zone plate test pattern is proposed to be used to assess the quality of the video display.

15.22. De-interlacing of standard-definition video meets PC 99 requirements*Required for all systems that support TV or DVD video playback***15.23. MPEG-2 decoder supports the pull-down algorithm***Recommended*

Technical Clarification: For information about implementing driver support, see the Video Port Extensions to DirectX topics in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2k/ddraw_7ehz.htm).

15.24. DVD decoder driver correctly handles media types, time discontinuity, and decode-rate adjustment*Required***15.25. DVD decoder supports subpicture compositing and closed captioning***Required for all system types, with exceptions for mobile PCs***15.26. Subpicture decoder correctly handles subpicture properties and other functions***Required for all system types, with exceptions for mobile PCs*

Technical Clarification: For information about implementing the minidriver for the subpicture decoder, see the Microsoft DirectX 5.1 SDK (online at http://www.microsoft.com/DirectX/dxm/help/ds/Ref/propset_dvd_subpicture.htm) and DVD Support in Windows 98 and Windows NT/Windows 2000 in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2k/dvdx_6p0w.htm).

15.27. System supports seamless DVD-Video 1.0 navigation*Required***15.28. All DVD video decoders must support Line21 closed-caption data***Required***15.29. System provides a licensed CSS copyright protection scheme***Required*

Technical Clarification: Playback of regionalized movies must be handled in accordance with the copy scramble system (CSS) requirements and the interfaces as defined in the Mt. Fuji 2.0 specification. Phase II regionalization (RPC II) is not required until after January 1, 2000.

Important: As noted in the disclaimer for *PC 99 System Design Guide*, Intel and Microsoft do not make any warranty of any kind that any item developed based on these specifications, or any portion of a specification, will not infringe any copyright, patent, trade secret, or other intellectual property right of any person or entity in any country. It is your responsibility to seek licenses for such intellectual property rights where appropriate. Intel and Microsoft shall not be liable for any damages arising out of or in connection with the use of these specifications, including liability for lost profit, business interruption, or any

other damages whatsoever.

- 15.30. Analog video decoder such as NTSC/PAL/SECAM meets PC 99 quality requirements**
Required

Technical Clarification: The compatibility tests for PC systems will determine whether there is excessive cross color, hanging dots, or other artifacts that could degrade the viewer experience. A laser disc player with the Joe Kane Video Essentials disk with the Snell and Wilcox Zone plate test pattern is proposed to be used to assess the video quality.

- 15.31. Analog video capture device outputs video data at 3.7 MB/sec, minimum**
Required

- 15.32. Video input or capture device provides raw sampled VBI data**
Required

- 15.33. Digital video camera uses external bus support**
Required

- 15.34. Video input image orientation identification meets PC 99 requirements**
Required

- 15.35. Analog TV tuner/decoder supports PC 99 audio and video performance**
Required

- 15.36. Analog TV tuner/decoder includes stereo audio decoder and supports SAP**
Recommended for all system types

- 15.37. VBI capture oversamples VBI data at least four times**
Required

- 15.38. VBI capture makes VBI data available to the CPU for processing**
Required

- 15.39. Digital broadcast module can receive all streams contained in the particular transport stream**
Required

- 15.40. Digital broadcast module can receive full bandwidth from each frequency**
Required

- 15.41. Digital broadcast module can receive a minimum of 16 simultaneous elementary streams**
Required

- 15.42. System can simultaneously receive two or more broadcast frequencies**
Recommended

- 15.43. Digital broadcast module provides support for conditional access**
Recommended

- 15.44. Digital broadcast module provides signal quality and other diagnostic information**
Required

- 15.45. Digital broadcast receiver module supports general-purpose data cryptography**
Recommended

- 15.46. Digital broadcast receiver module supports stream filtering**
Recommended

- 15.47. **ATSC DTV tuner/demodulator is fully implemented**
Required
- 15.48. **Stream splitting is supported using DirectShow filters**
Recommended
- 15.49. **Each hardware device has a Plug and Play device ID**
Required
- 15.50. **Dynamic resource configuration is supported for all devices**
Required
- 15.51. **Dependent video device is not independently enumerated**
Required
- 15.52. **Device drivers and installation meet PC 99 requirements**
Required
- 15.53. **Software drivers are installed during hardware driver installation**
Required
- 15.54. **Applications provided with device meet Win32 requirements**
Required
- 15.55. **NDIS 5.0 miniport driver provided for digital broadcast receiver**
Required

Addendum for Monitors

PC 99A Recommendations for Digital Visual Interface

As the industry begins to move from analog to digital technologies, PC displays are poised for some dramatic changes. New space-saving and ergonomic flat-panel technologies are emerging, based on thin-film transistor (TFT) LCDs and plasma technologies. At the same time, the display interface is beginning its transition from VGA to pure digital technology. Both of these trends promise to create significant new opportunities for developers. The implementation of new flat-panel digital display products has been slowed by industry fragmentation caused by the multiple technical specifications that now exist. A universal and industry-wide digital display interface specification is essential to enable the more rapid and widespread adoption of these new display technologies.

While several technologies now exist that try to address the digital display interface issue, these are based on proprietary technologies and take different approaches. As a result, display interface technologies have not been open to all developers, and the goal of platform-independence has remained out of reach.

To address the fragmentation of the industry, a working group of seven companies was formed to create a robust, comprehensive, and extensible industry specification. This specification, *Digital Visual Interface (DVI)*, defines the digital interface between digital displays and the PC. The DVI specification addresses protocol, electrical, and mechanical definitions, and is the first specification written expressly for the Transition Minimized Differential Signaling (TMDS) digital interface, which

ensures a degree of backward-compatibility with earlier approaches. The DVI specification is available at <http://www.ddwg.org>.

Implementing DVI-compliant products enables developers to immediately save costs by eliminating digital-to-analog conversion functions, while laying the groundwork for the eventual elimination of analog technology altogether. For PC users, digital displays provide sharper, more realistic visual experiences and automatically adjust to optimal resolution levels.

Microsoft and Intel recommend that any digital display interface implemented after 1H99 be based on DVI-V or DVI-I, with the Analog VGA port being optional (for legacy monitor support) for systems and graphics cards.

When implementing DVI, a designer should keep in mind the following emerging standards and features.

Support for VESA EDID Structure 1.3. VESA is nearly done with the definition for the 1.3 Extended Display Identification Data (EDID) structure. This definition is important for flat panel and future digital monitors because the existing data structure does not provide complete or adequate support for various digital display parameters. When VESA completes this structure, it will be required for DVI displays. Therefore, it will require appropriate support from both graphics drivers and operating system registration facilities. This will become a hardware requirement one year after adoption by VESA.

No date has been announced for operating system support at the time of this publication.

Support for Hot Plug Monitor Detection. A monitor hot-plug detection mechanism notifies the graphics controller that a monitor has been either plugged in or disconnected. The display driver must notify the operating system when a new display has been plugged in or disconnected. This change is determined by checking the voltage level of the Hot Plug Detection pin. If that pin transitions from low to high, a new monitor has been plugged in. If this pin transitions from high to low, the display has been disconnected. This mechanism is a requirement for DVI displays.

It is recommended that graphics chips implement hardware support for this feature in chip sets being introduced after 1H99.

Color-coding Scheme for Connectors. The color coding scheme recommended in item 3.18.3 for a Digital monitor/flat panel is white. It is recommended that this digital implementation follow this color scheme. Both DVI-V (Digital only) and DVI-I (Digital with Analog Micro-cross) should be white.

PC 99A Digital Interface Recommendation. Microsoft and Intel recommend that any digital display interface implemented after 1H99 be based on DVI-V or DVI-I, with the analog VGA port being optional (for legacy monitor support) for systems and graphics cards. Any external digital display interface will be required to be based on the DVI specification in future design guidelines.

Intel and Microsoft anticipate that the digital interface will also be implemented for devices that normally would use an analog interface (such as CRT-based monitors).

16.1. Color monitor is DDC2B-compliant with unique EDID identifier
Required

Technical Clarification: The required support defined in Version 3.0 of these standards is also defined in the earlier version and revisions of these standards. As such, the Version 3.0 standards provide the correct references for both Windows 2000 and Windows 98.

The Image Color Management (ICM) APIs and functionality for Windows and Windows 2000 are described in the Microsoft Platform SDK and Color Management for Displays in Part 2 of Graphics Drivers Design Guide in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/dpyddi_8hev.htm).

16.2. Monitor supports Integrated Color Management
Required

Technical Clarification: The default profile should be for the optimal display mode supported by the display. Typically, this mode is defined by the display manufacturer. Specifically, there is no need to have a separate default ICM profile for each color depth or resolution.

Mobile PC Note

Note: Because most Mobile PCs do not support Plug and Play for their installed LCD panel, the ICC profile must be installed manually using an appropriate monitor INF. OEMs should install the correct configuration as part of the operating system pre-install process. If necessary, the INF will be available to the user for manual re-installation.

16.3. Monitor meets all PC 99 general device and driver requirements
Required

Technical Clarification: Monitor support for Windows is installed using a monitor INF file, as defined in INF and Installation Requirements in Part 2 of Graphics Drivers Design Guide in the Windows 2000 DDK and in Sample Display INF File of Windows 95 Documentation Programmers Guide in the Windows 98 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/vidintro_9von.htm and http://www.microsoft.com/ddk/ddkdocs/win98ddk/devinst_167q.htm, respectively).

16.4. CRT-based monitor supports a mechanism for control from host software
Recommended

16.5. Monitor meets minimum graphics resolution, based on monitor size
Required

16.6. CRT-based monitor supports ergonomic timing standards
Required

16.7. CRT-based monitor synchronizes to a new format in a timely fashion
Recommended

16.8. Large-screen monitor is 20 inches (viewable diagonal) or larger if included with an Entertainment PC system
Required

- 16.9. **Entertainment CRT-based monitor supports 800 × 600 at 60 Hz refresh rate**
Required
- 16.10. **Entertainment monitor operates at the lower scan rates used by the operating system**
Required
- 16.11. **Entertainment monitor's host control has digitally controlled geometry**
Recommended
- 16.12. **External monitor meets DDC2B and EDID standards**
Required
- Technical Correction:** For analog CRTs, Extended Display Identification Data (EDID) content must indicate at least one VESA mode at 75 Hz, or better, for each resolution supported.
- 16.13. **Monitor complies with device class power management reference specification**
Required

Addendum for Audio Components

| | Consumer | Office | Mobile | Workstation | Entertainment |
|-------|---|--------------------|--------------------|--------------------|-----------------|
| 17.1. | PC system includes PC 99 audio capabilities | | | | |
| | <i>Recommended</i> | <i>Recommended</i> | <i>Recommended</i> | <i>Recommended</i> | <i>Required</i> |
| 17.2. | Audio device does not connect to ISA bus | | | | |
| | <i>Required for all system types</i> | | | | |
| 17.3. | Audio device does not use legacy hardware interfaces for MS-DOS-based applications | | | | |
| | <i>Required for all system types</i> | | | | |
| 17.4. | Audio performance meets PC 99 requirements | | | | |
| | <i>Required, with exceptions for mobile PCs</i> | | | | |
| | <p>Technical Clarification: Windows 98 and Windows 2000 provide software mixing and sample rate conversion (SRC), which eliminate the need for hardware to support all possible rates. Therefore, the hardware is required to support only two key rates: 44.1 and 48kHz:</p> <ul style="list-style-type: none"> 44.1kHz is required for efficiency reasons. Most game content uses a sampling rate that is an integer multiple of 44.1 kHz. In addition, CD audio is 44.1kHz. When the highest input stream is 44.1kHz and below, the optimal way to operate the audio output is to convert everything to 44.1kHz and run the audio device at this rate. This provides the best quality and least CPU overhead. 48kHz is required because it is the highest frequency that consumer content uses. DVD audio is a good example. When 48kHz content is present, the operating system will switch the audio output to 48kHz. | | | | |
| 17.5. | Audio subsystem supports basic data formats in full duplex | | | | |
| | <i>Required</i> | | | | |
| | <p>Technical Clarification: For all cases in this requirement (and similar audio requirements), the reference should be to "audio hardware," and <i>not</i> to "audio codec hardware." Also:</p> | | | | |

- **17.5.1 Output.** The built-in or external audio hardware must support 16-bit stereo at 44.1 and 48 kHz at minimum. Output performance must meet or exceed minimum requirements stated in requirement 17.4.
 - **17.5.2 Input.** The built-in or external audio hardware must support 16-bit stereo at 44.1 and 48 kHz at minimum. Input performance must meet or exceed minimum requirements stated in requirement 17.4.
- 17.6. Audio subsystem supports full-duplex operation at independent sampling rates**
Required
- 17.7. Analog microphone input meets PC 99 jack and circuit specifications**
Required
- Technical Correction:** Three-conductor 1/8 inch (3.5 mm) tip/ring/sleeve microphone jack where the mic signal is on the tip, bias is on the ring, and the sleeve is grounded. This design is optimized for electret microphones with three-conductor plugs, but will also support dynamic microphones with two-conductor (ring and sleeve shorted together) plugs.
- Minimum AC input impedance between tip and ground: minimum, 4 kOhm; recommended, 10 kOhm.
- 17.8. Audio driver reports sample position for stream synchronization**
Required
- Technical Clarification:** For information about WDM device driver support for streaming capabilities, see the 'Kernel Streaming Drivers Design Guide' in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/ks-overview_4svn.htm).
- 17.9. Audio connectors use icons with color coding**
Required
- 17.10. Audio subsystem provides sufficient externally accessible inputs and outputs**
Recommended
- 17.11. Microphone meets performance recommendations for PC 99 speech-recognition microphones**
Recommended
- 17.12. Audio subsystem provides hardware or software support for DLS**
Recommended
- 17.13. Audio subsystem supports AEC reference inputs**
Recommended
- 17.14. Audio subsystem provides hardware filtering of 3-D localization filters**
Optional
- 17.15. CD, DVD, and broadcast audio playback meet PC 99 requirements**
Required with systems that support video playback
- 17.16. Audio subsystem provides consistent volume levels for different devices**
Optional
- 17.17. Audio subsystem does not provide a DB-15 analog joystick/MIDI port**
Recommended

- 17.18. Each hardware device has a unique Plug and Play device ID**
Required
- 17.19. Dynamic resource configuration is supported for all devices**
Required
- 17.20. PCI device conforms to PCI 2.1 and additional PC 99 requirements**
Required
- 17.21. PCI device supports initiator, target, and block transfer**
Required
- 17.22. PCI device supports non-DWORD-aligned audio buffers**
Recommended

Technical Clarification: This item is recommended, not required. The following items are added to the recommendations for item 17.22, and might become requirements in future Design Guide guidelines.

- The audio device should not consume more than two percent of the CPU transferring audio data. This is two percent for all streams, not per stream.
- The audio device should be able to fully function when the system can only provide single pages of contiguous memory. In other words, the audio device can require many pages of memory, but should not require the largest block of contiguous memory to exceed one page. This ensures audio support in docking and dynamic loading scenarios where memory may be completely fragmented page-wise.
- The audio device should not introduce more than 1ms latency. In this context, latency is defined as the time between when the driver receives the audio data and when the audio data leaves the device.

The intent here is to provide performance guidelines for developers, rather than to specify implementation requirements.

- 17.23. PCI device does not use ISA-based resources**
Required
- 17.24. PCI device is digital ready**
Required
- 17.25. Audio meets USB specification and USB audio device class specification**
Required
- 17.26. USB audio device uses MMHID for control of basic functions**
Required
- 17.27. Audio meets PC 99 requirements for IEEE 1394**
Required
- 17.28. System and device comply with PCI bus power management specification**
Required
- 17.29. Audio device complies with device class power management reference specification**
Required
- 17.30. Device drivers and installation meet PC 99 requirements**
Required

17.31. Audio meets PC 99 requirements for WDM driver support
Required

Technical Clarification: For information about WDM device driver support for audio, see WDM Audio Driver Design Guide in the Kernel Streaming Design Guide in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/aud-design_5rn7.htm).

17.32. Applications provided with device meet Win32 requirements
Required

Addendum for Storage and Related Peripherals

18.1. Storage controller and hard disk devices support bus master capabilities
Required

Technical Correction: ATA and ATAPI devices must meet the following support requirements and recommendations for Ultra DMA and IDE Bus Master DMA.

Support for Ultra DMA:

- Required for ATA controllers and ATA devices
- Recommended for ATAPI peripherals

However, ATAPI devices might be connected to the ATA bus (which is required to support UDMA). Therefore, to ensure that ATAPI devices will tolerate Ultra DMA, ATAPI devices must support the termination scheme as defined in ATA/ATAPI-4 or SFF 8038i.

Support for IDE Bus Master DMA:

- Required for ATA controllers
- Required for ATA devices and ATAPI peripherals, including CD and DVD devices
- Recommended for ATA/ATAPI tape drives
- Recommended for ATAPI removable media drives

18.2. Removable media devices support media status notification
Required

Technical Correction: The intent of this requirement is for devices to support the commands of the implemented bus interface so the operating system can detect when a media event has taken place. The requirements for removable storage devices are as follows; they apply either to single LUN devices or to devices that are part of a Multiple LUN device:

| Device type | Media status notification implementation |
|---|---|
| All CD or DVD devices (independent of interconnect) | Required. Comply with <i>ANSI NCITS T10 Multi-Media Command Set-2 (MMC-2)</i> standard for Media Status Event Notification. |
| ATAPI floppy/optical direct access drives (PD, MO, removable magnetic floppy or rigid based, and so on.) | Required. Comply with either MMC-2 standard or SFF 8070i Version 1.1. See Chapter 18 section 24. |
| IEEE 1394 storage devices (non-CD / DVD) | Required. Comply with <i>NCITS Reduced Block Commands</i> (RBC; T10/97-260r0) standard. |
| ATA and non-ATAPI (IDE interconnect) storage devices | Required. Comply with <i>Media Status Notification Support, Version 1.03</i> . |
| Other ATA/ATAPI devices, including tape drives | Recommended. If implemented, comply with <i>Media Status Notification Support Specification, Version 1.03</i> , or SFF 8070i. |
| Other types of SCSI removable devices | Recommended. If implemented, support based on <i>NCITS Reduced Block Commands</i> standard is recommended. |

18.3. Device meets PC 99 general device requirements*Required***18.4. Device meets PC 99 requirements for ports or buses***Required***18.5. Device Bay storage device meets PC 99 requirements***Required***18.6. ATA controllers and devices support Ultra DMA***Required***Technical Correction:** See correction for item 3.47.

Technical Clarification: Under requirements for ATA controllers and devices to support Ultra DMA, implementations based on ATA/66 are compliant with this requirement.

Performance capabilities defined for CD and DVD devices in *PC 99 System Design Guide* are no longer based on the traditional marketing performance criteria such as 8X, 24X, and so on. Performance specifications are now based on the minimum sustained transfer rate that occurs anywhere on the disk; this allows a realistic evaluation of the actual performance of the device.

Mobile PC Note

Technical Clarification: This feature is *recommended* for controllers in docking stations. Controllers in mobile PC units are *required* to support Ultra DMA.

This is only a recommendation for controllers in docking stations because of a lack of controllers that support Ultra DMA and provide fully-relocatable resources. Under Windows 2000, controllers that do not have fully-relocatable resources will not function in a docking station.

- 18.7. **USB-based mass storage device meets PC 99 requirements for USB**
Required
- 18.8. **System BIOS or option ROM supports El Torito No Emulation mode**
Required
- 18.9. **System BIOS or option ROM supports bootable ARMD**
Recommended
- 18.10. **Host controller for secondary storage uses IEEE 1394**
Recommended
- 18.11. **Floppy disk capabilities, if implemented, do not use legacy FDC**
Recommended for all system types
- 18.12. **Legacy FDC device meets resource configuration requirements, if present**
Required
- 18.13. **System supports dynamic configuration of legacy FDC**
Required
- 18.14. **Operating system recognizes the boot drive in a multiple-drive system**
Required
- 18.15. **Hard drive is SMART-compliant and uses SMART IOCTL API**
Optional
- 18.16. **CD device provides 8x minimum transfer rate or better performance**
Required
- 18.17. **CD drive is CD-Enhanced compatible**
Required
- 18.18. **CD drive supports specified logical and physical CD formats**
Required
- 18.19. **ATA/ATAPI CD drive complies with SFF 8020i v. 2.6**
Required
- 18.20. **CD drive supports multisession and compatibility forms of the READ_TOC command**
Required
- 18.21. **ATA/ATAPI CD changer complies with the MMC-2 standard**
Required
- 18.22. **CD device supports digital audio detection**
Required

Technical Correction: CD and DVD drives must implement CD Capabilities and Mechanical Status Page (2Ah), as defined in the MMC-2 standard. The bit 'CD-DA Commands Supported' must be set and the functionality must be implemented.

CD and DVD drives must also implement and set the bit 'CD-DA Stream is Accurate' of CD Capabilities and Mechanical Status Page. The READ_CD command and READ_RAW commands must provide sector-accurate reads, as defined in MMC-2. Data alignment accuracy must be equivalent to that of data reads. Because of the lack of error correction code (ECC) bytes used for data tracks, the data itself may contain inaccuracies due to physical defects of the media.

18.23. CD device uses push-to-close design
Recommended

18.24. Block rewritable optical ATAPI device complies with SFF 8070i
Required

18.25. DVD device provides 2 MB per second minimum transfer rate or better performance anywhere on the disc
Required

Clarification: This requirement has been changed to read DVD device provides 2 MB per second minimum transfer rate or better performance. The supporting text for the requirement remains the same.

18.26. DVD drive and controller support bus master DMA transfers
Required

18.27. DVD drive meets minimum compatibility requirements
Required

Technical Correction: Recommended: Support for ECMA-274 (+RW) and ECMA-272, 273 (DVD-RAM) and DVD-R.

18.28. DVD device complies with the MMC-2 standard
Required

18.29. DVD device uses push-to-close design
Recommended

18.30. DVD device supports defect management
Required

Technical Correction: Defect management for +RW media is defined in ECMA-274.

18.31. DVD device supports copyright protection
Required

18.32. Each device has a Plug and Play device ID
Required

18.33. Dynamic resource configuration is supported for all devices
Required

18.34. 3F7h and 377h are unclaimed by devices
Required

18.35. Physical security is provided for storage devices
Recommended

18.36. Option ROMs support Int 13h Extensions
Required

Technical Clarification: This requirement also applies for RAID controllers implemented on client systems such as workstations.

The Int 13h Extensions are defined in Chapter 14: Int 13 Extension APIs in the Storage Technology Reference in the Windows 95 Documentation in the Windows 98 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win98ddk/storage_60q9.htm).

18.37. Device and controller comply with device class power management reference specification
Required

18.38. Device supports wake-up events
Optional

18.39. Device drivers and installation meet PC 99 requirements
Required

Technical Clarification: For information about storage device driver support under Windows 2000, see Part 3: Storage Drivers in the Kernel-Mode Drivers Reference in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/k301_2ur6.htm).

For information about storage device driver support under Windows 98, see Storage Technology Reference in the Windows 95 DDK (included with the Windows 98 DDK and available online at http://www.microsoft.com/ddk/ddkdocs/win98ddk/storage_5ku1.htm).

For information about WDM support for devices that use the USB or IEEE 1394 bus, see Part 5: USB Drivers and Part 6: IEEE 1394 Drivers in the Kernel-Mode Drivers 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/usbirp_85rm.htm).

18.40. Device driver runs in protected mode following installation
Required

18.41. Applications provided with the device meet Win32 requirements
Required

18.42. Device driver for partitioned media supports all Windows and Windows 2000 partition types
Required

18.43. Device driver for block-mode device supports extended BPBs
Required

Technical Clarification: For information, see Chapter 1: Layered Block Device Drivers in the Storage Technology Reference in the Windows 98 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win98ddk/storage_5kvk.htm).

Addendum for Modems

| | Consumer | Office | Mobile | Workstation | Entertainment |
|--|----------|-------------|----------|-------------|---------------|
| 19.1. Modem device is provided with PC system | | | | | |
| | Required | Recommended | Required | Recommended | Required |
| Errata: A modem or other communications support is not required for Workstation systems. | | | | | |
| 19.2. Modem controller meets PC 99 requirements | | | | | |
| | Required | | | | |
| 19.3. Modem supports V.250 AT command set | | | | | |
| | Required | | | | |

Technical Clarification: Windows Unimodem does not use the following commands directly; therefore, these are not in the sample INF and are not required: +ICF, +MA, +EB, +ESR, +ETBM. These commands are only required if the function is controllable in the modem by way of AT commands; in that case, the standard V.250 commands defined here must be included.

- 19.4. **Data modem supports V.90 (1998) analog modem modulation**
Required
- 19.5. **Data modem supports Annex A/V.34 (1998) SRC**
Recommended
- 19.6. **Data modem supports V.42 LAPM, V.42 bis, and V. 80 Synchronous Access data protocols**
Required
- 19.7. **Modem supports call control signaling, controlled using V.251 modem commands**
Required
- 19.8. **Fax modem supports 14.4 Kbps (V.17) with Class 1 (TIA-578-A) command set**
Required
- 19.9. **Modem supports delayed and blacklisted number clearing**
Recommended
- 19.10. **Modem supports TDD, meeting V.18-1996 with V.250 AT commands**
Recommended
- 19.11. **Voice modem supports ITU V.253 (AT+V)**
Required in modems supporting voice

Technical Clarification: This requirement includes support for +VTR (full-duplex voice).
- 19.12. **Voice modem support includes PC 99 recommendations**
Recommended
- 19.13. **Voice modem supports Caller ID Detection and Reporting**
Recommended
- 19.14. **Voice modem supports speakerphone**
Required in modems supporting voice
- 19.15. **Wireless support is implemented for modems**
Recommended
- 19.16. **Digital cellular phone support is implemented for modems**
Recommended
- 19.17. **ISDN driver supports unattended installation, with limitations**
Required
- 19.18. **ISDN modem supports required command set**
Required
- 19.19. **ISDN modem exposes both B channels**
Recommended
- 19.20. **ISDN modem supports asynchronous-to-synchronous conversion**
Required

19.21. ISDN modem defaults to HDLC PPP after INF installation
Recommended

19.22. ISDN modem uses high-speed port
Recommended

19.23. Modem pair passes basic V.34 file transfer test
Required

19.24. Modem pair passes basic call connect reliability test
Required

19.25. Modem pair passes concurrency test
Required

Technical Clarification: A standard concurrency test procedure will be published as part of the Modem Compatibility Test suite, which defines hardware compatibility with Windows operating systems. This will become part of compliance testing when a comprehensive and reproducible concurrency test is available.

19.26. Driver-based modem uses a WDM-based driver solution
Required

19.27. Driver-based modem processor usage is not excessive
Recommended

19.28. Driver does not disable interrupts for excessive periods of time
Recommended

19.29. Driver handles thread priorities appropriately
Recommended

Technical Clarifications:

- **19.29.2:** Revised sentence: 'At any instant in time, the total execution time required for all delayed procedure calls (DPCs) that have been queued by a WDM driver-based modem, but have not dequeued and started executing, should not exceed 500 milliseconds.'
- **19.29.3:** Revised sentence: 'A WDM driver-based modem should not continuously disable thread preemption for more than 4.4 milliseconds. This guideline accommodates 400 microseconds of interrupts being disabled together with two back-to-back episodes of 2.0 milliseconds of extended processing at DISPATCH_LEVEL, as up to four 500-microsecond DPCs execute sequentially.'

19.30. Driver tolerates reasonable operating system and bus latencies.
Recommended

Technical Clarifications:

- **19.30.1:** Revised sentence: 'A driver-based modem should be able to tolerate a period of 4 milliseconds with interrupts disabled.'
- **19.30.2:** Revised sentence: 'A driver-based modem should be able to tolerate a continuous period of 8 milliseconds during which a queued DPC is held off from execution, possibly by other DPCs.'
- **19.30.3:** Revised sentence: 'A WDM driver-based modem should be able to

tolerate a 16-millisecond period when thread scheduling is continuously disabled.”

19.31. Driver does not make excessive use of locked memory
Recommended

19.32. Each hardware device has a unique Plug and Play device ID
Required

19.33. Each device has a Plug and Play compatible ID
Required

19.34. Dynamic resource configuration is supported for all devices
Required

19.35. PCI modem meets PC 99 requirements
Required

19.36. USB modem meets PC 99 specifications
Required

19.37. Device Bay modem meets PC 99 requirements
Required

19.38. Device complies with device class power management reference specification
Required

Technical Clarification: Support for power states D0 and D3 cold are required for PCI modems, including wake on ring.

19.39. Device supports wake-up events
Required

Technical Clarification: PCI devices are required to support D3 cold on a PCI 2.2-based system with auxiliary power. On all other power-managed buses (such as USB), support for either D2 or D3 is acceptable.

19.40. Device drivers and installation meet PC 99 requirements
Required

Technical Clarification: For information about WDM-based support for controllerless and software modems, and for guidelines about implementing driver and installation support for modems under the Windows operating system, see the Windows Modem Development Kit (MDK) in the Supplemental Documentation”section of the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/mdk_6y3j.htm).

19.41. Driver supports Unimodem
Required

19.42. Applications provided with device meet Win32 requirements
Required

Addendum for Network Communications

| | <i>Consumer</i> | <i>Office</i> | <i>Mobile</i> | <i>Workstation</i> | <i>Entertainment</i> |
|--|-----------------|---------------|---------------|--------------------|----------------------|
| 20.1. PC system includes network adapter <i>Recommended Required Recommended Required Recommended</i> | | | | | |
| 20.2. PC system includes internal or external ISDN device <i>Recommended* Recommended Recommended Recommended Recommended*</i> | | | | | |
| 20.3. PC system includes cable modem <i>Recommended* Recommended Recommended Recommended Recommended*</i> | | | | | |
| 20.4. PC system includes ATM adapter <i>Optional Optional Optional Optional Optional</i> | | | | | |
| 20.5. PC system includes ADSL adapter <i>Recommended* Recommended Recommended Recommended Recommended*</i> | | | | | |
| 20.6. PC system includes satellite or broadcast receiver with NDIS driver <i>Recommended* Recommended Recommended Recommended Recommended*</i> | | | | | |
| 20.7. Adapter uses NDIS 5.0 miniport driver <i>Required</i> | | | | | |
| <p>Technical Clarification: Network adapter drivers must follow the NDIS miniport driver model defined in 'Network Drivers Design Guide and Reference' in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/101rm_9t9j.htm).</p> <p>Guidelines for connection-oriented media are presented in Part 2, Chapters 1-7, 9 and Part 4, Chapter 1 of the 'Network Drivers Design Guide' in the Windows 2000 DDK.</p> <p>Documentation for both integrated and separated call managers is included in Part 4: 'Connection-Oriented NDIS' in the 'Network Drivers Design Guide' in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/401condis_8cfb.htm).</p> | | | | | |
| 20.8. Intermediate NDIS 5.0 miniport driver is deserialized <i>Recommended</i> | | | | | |
| 20.9. Full-duplex adapter automatically detects and switches to full duplex mode <i>Required</i> | | | | | |
| 20.10. Adapter automatically senses presence of functional network connection <i>Required</i> | | | | | |
| <p>Technical Clarification: For information about NDIS status codes and indication mechanisms, see the NdisMIndicateStatus topic in the 'Network Reference' in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/103ndisx_5nn6.htm).</p> | | | | | |
| 20.11. Adapter automatically senses transceiver type <i>Required</i> | | | | | |
| 20.12. Adapter can transmit packets from buffers aligned on any boundary <i>Required</i> | | | | | |
| 20.13. Adapter communicates with driver across any bridge <i>Required</i> | | | | | |

- 20.14. **Adapter supports filtering for at least 32 multicast addresses**
Required
- 20.15. **Adapter and driver support promiscuous mode**
Required
- 20.16. **Adapter is compatible with remote new system setup capabilities if used as a boot device**
Required
- 20.17. **PCI network adapters are bus masters**
Required
- 20.18. **Device Bay-type network adapter meets PC 99 requirements**
Required
- 20.19. **USB or IEEE 1394 device meets specifications for network communications devices**
Recommended
- 20.20. **Network adapter and driver supports priority for IEEE 802-style networks**
Recommended

Technical Clarification: For more information, see 'Quality of Service' in the Network Drivers Design Guide in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/401condis_5dyf.htm). See also the white paper 'QoS: Assigning Priority in IEEE 802-style Networks,' available on the web at <http://www.microsoft.com/hwdev/devdes/qos.htm>.
- 20.21. **Internal ISDN device meets PC 99 network adapter requirements**
Required
- 20.22. **Internal ISDN device supports synchronous HDLC framing**
Required
- 20.23. **NDIS interface and driver support raw unframed synchronous B channel I/O**
Required
- 20.24. **ISDN driver supports unattended installation, with limitations**
Required
- 20.25. **ISDN device with U-interface includes built-in NT-1 capability**
Recommended
- 20.26. **ISDN device includes software-selectable terminating resistors**
Required
- 20.27. **Device is implemented as an integrated cable modem**
Recommended
- 20.28. **Integrated cable modem meets PC 99 network adapter requirements**
Required
- 20.29. **Integrated cable modem exposes an ATM or Ethernet interface**
Required
- 20.30. **ATM adapter meets PC 99 network adapter requirements**
Required
- 20.31. **ATM adapter supports a minimum number of simultaneous connections**
Required

Technical Correction: For the Client (Integrated ATM/ADSL adapter), the minimum required support is for 16 simultaneous connections.

Technical Clarification: A sample driver is provided at %ntddk%\src\network\ndis\atmsmple in the Windows 2000 DDK to guide developers in properly supporting resources to meet this requirement.

- 20.32. **ATM adapter supports all service types defined by the ATM Forum**
Recommended
- 20.33. **ATM adapter supports UBR service type**
Required
- 20.34. **ATM adapter supports a minimum number of simultaneously active VBR or CBR connections**
Required
- 20.35. **ATM adapter supports traffic shaping**
Required
- 20.36. **ATM adapter enforces PCR on UBR virtual circuits**
Required
- 20.37. **ATM adapter and driver support dynamic link speed configuration**
Required
- 20.38. **ATM adapter supports OAM**
Recommended
- 20.39. **ATM adapter supports buffer chaining (Tx + Rx)**
Recommended
- 20.40. **ADSL device is implemented as an integrated ADSL modem**
Recommended
- 20.41. **Integrated ADSL modem meets PC 99 network adapter requirements**
Required
- 20.42. **ATM/ADSL solution is implemented for integrated ADSL modems**
Recommended
- 20.43. **ADSL modem supports DMT line encoding**
Recommended
- 20.44. **ADSL modem supports rate adaptation**
Recommended
- 20.45. **Infrared device meets PC 99 network adapter requirements**
Required
- 20.46. **Infrared device supports both FIR and SIR**
Required
- 20.47. **IrDA hardware supports unattended driver installation**
Required
- 20.48. **Home networking adapter meets PC 99 network adapter requirements**
Required
- 20.49. **Home networking uses appropriate media**
Recommended

- 20.50. **Home networking media supports IP**
Required
- 20.51. **Each device has a unique Plug and Play device ID**
Required
- 20.52. **Dynamic resource configuration is supported for all devices**
Required
- 20.53. **Plug and Play capabilities support multiple adapters**
Required
- 20.54. **All resource settings are reported in the user interface**
Required
- 20.55. **Device complies with device class power management reference specification**
Required
- 20.56. **Device supports wake-up events**
Required
- 20.57. **Device drivers and installation meet PC 99 requirements**
Required
- 20.58. **Driver works correctly with Microsoft network clients and protocols**
Required
- 20.59. **NDIS miniport driver makes only NDIS library calls or WDM system calls**
Required
- 20.60. **NDIS 5.0 driver uses new INF format**
Required

Technical Clarification: For information about supporting wake-up events in NDIS miniport drivers, see Chapter 6: Power Management for Miniports'in Part 2: Miniport NIC Drivers'in the Network Drivers Design Guide'in Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/206pm_9h0n.htm).

Technical Clarification: For information about the INF format, see Chapter 4: Installing Network Components'in Part 1: Network Drivers'in the Network Drivers Design Guide'in Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/104install_312f.htm).

Note: For items marked with an asterisk (*) symbol, it is recommended to implement an ADSL modem, ISDN device, or home networking adapter.

Addendum for Printers

- 21.1. **IEEE 1394 printer meets PC 99 requirements for IEEE 1394**
Required
- 21.2. **USB printer meets PC 99 requirements for USB devices**
Required

Technical Clarification: The USB bus is a requirement for PC 99 systems. USB printers must conform to the Universal Serial Bus Device Class Definition for Printing

Devices, Version 1.1 or later. For information about implementing USB for PC 99, see Chapter 7, USB.”

21.3. IEEE 1284 printer supports compatibility mode, nibble mode, and ECP, compliant with IEEE 1284-I
Required

21.4. IEEE 1284 printer meets IEEE 1284-II requirements
Recommended

21.5. ECP printer works correctly when ECP mode is turned off
Required

21.6. IEEE 1284 hardware supports error notification
Required

21.7. Daisy-chained parallel port device is Plug and Play capable
Required

21.8. Network printer supports standard port monitor
Required

21.9. Plug and Play support implemented for all supported buses
Required

21.10. Peripheral device meets IEEE 1284 requirements
Required

21.11. Printer INF file and installation meet PC 99 requirements
Required

Technical Clarification: For information about printer INF format for Windows 2000, see Chapter 10: Installing and Configuring Printer Drivers’in Part 3: Printer Drivers and Spooler Components’in the Graphics Drivers Design Guide’in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/prtinst_02lj.htm).

For information about the INF format for Windows 98, see Printer INF File Extension’and Printer-Specific INF File Extensions Reference’in Windows 95 Documentation’in the Windows 98 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win98ddk/devinst_19f7.htm).

21.12. Driver correctly reports device capabilities
Required

Technical Clarification: For Windows 98, DEVMODE structure is defined in the New Function and Structure Reference’of the Printer Driver Overview’in Windows 95 Documentation’in the Windows 98 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win98ddk/printer_0qwk.htm).

For Windows 2000, DEVMODEW structure is defined in the Chapter 3: Graphics Driver Structures’in Part 1: Common Graphics Driver Interface’in the Graphics Drivers Reference’of the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/grstrcts_6v8n.htm).

21.13. Driver supports error notification
Required

21.14. Driver supports ICC color management
Required

Technical Clarification: Implementation details are defined in Chapter 12: Color Management for Printers in Part 3: Printer Drivers and Spooler Components of the Graphics Drivers Design Guide in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/printicm_77vr.htm).

21.15. Port monitor software meets DDK guidelines
Required

Technical Clarification: For implementation information about port monitor software, see Writing a Print Monitor in Part 3: Printer Drivers and Spooler Components of the Graphics Drivers Design Guide in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/provider_6cyv.htm).

21.16. Driver supports point-and-print network installation
Required

21.17. Device is available immediately following installation
Required

21.18. Device supports accurate printable regions
Required

21.19. Driver supports required DDIs
Required

Technical Change: It is strongly recommended that printer drivers run only in user mode. Drivers that run in kernel mode can incur stability problems. For driver implementation guidelines, see Part 3: Printer Drivers and Spooler Components in the Graphics Drivers section of the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2k/printro_592f.htm). See also Choosing User Mode or Kernel Mode in the DDK (online at http://www.microsoft.com/DDK/ddkdocs/Win2k/drvarch_2ief.htm).

This is expected to be a requirement in future versions of these guidelines.

Technical Clarification: The required DDIs for Windows 2000 printer drivers are defined in Part 3: Printer Drivers and Spooler Components in the Graphics Drivers Reference of the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/spoolfnc_6rl3.htm).

The required DDIs for Windows 98 printer drivers are defined in the Printer Driver Reference in the Windows 95 Documentation in the Windows 98 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win98ddk/printer_0r1v.htm).

21.20. Driver is based on Unidriver
Recommended

Technical Clarification: For information about the Unidrv for Windows 2000, see Chapter 4: Microsoft Universal Printer Driver in Part 3: Printer Drivers and Spooler Components of the Graphics Drivers Reference in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/nt5gpd_4mcn.htm).

For information about the Unidriver for Windows 98, see the 'Printer Driver Overview' in the 'Windows 95 Documentation' in the Windows 98 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win98ddk/printer_001f.htm).

Addendum for Digital Still Image Devices

22.1. Device uses PC 99 compatible port connection with USB or IEEE 1394 connection
Required

22.2. Icons provided for port and peripheral connectors
Required

22.3. Device supports ICC color management
Required

Technical Clarification: Implementation details are defined in 'Color Management for Still Image Devices' in Part 4: 'Still Image Drivers' of the 'Graphics Drivers Design Guide' in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/stilling_1f3b.htm).

22.4. IR device meets PC 99 IR requirements
Required

22.5. Digital still image device with an IR interface uses Fast IR
Required

22.6. Digital still image device with an IR interface provides a secondary PC interface
Required

22.7. SCSI device meets PC 99 SCSI requirements
Required

22.8. SCSI device attaches to any PC 99-compliant SCSI controller
Required

22.9. USB device meets PC 99 USB requirements
Required

22.10. USB device supports string descriptors
Required

22.11. USB imaging device has a zero-bandwidth alternate interface
Recommended

22.12. USB device does not saturate the USB bus
Recommended

Technical Clarification: This limitation refers to the bandwidth a device can request for *isochronous* transfers. Other types of data transfers are managed by the host controller.

22.13. USB device follows PC 99 USB performance recommendations
Required

22.14. Digital camera uses PC-compatible file system for removable storage
Required

- 22.15. **Digital camera stores images in common file formats such as JPEG or FlashPix**
Recommended
- 22.16. **IEEE 1394 device meets PC 99 requirements for IEEE P1394.a**
Required
- 22.17. **Serial device complies with Plug and Play External COM Device Specification v. 1.0**
Required
- 22.18. **Plug and Play capabilities implemented for all supported buses**
Required
- 22.19. **Each device has a Plug and Play device ID**
Required
- 22.20. **Daisy-chained parallel port imaging devices must be Plug and Play capable.**
Required
- 22.21. **Device supports power management requirements for its bus**
Required
- 22.22. **Device drivers and installation meet PC 99 requirements**
Required
- 22.23. **Driver support is implemented under the Still Image architecture**
Required

Technical Clarification: For information about the Still Image architecture and WDM Stream Class support, see Part 4: Still Image Drivers of the Graphics Drivers Design 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/stilling_1iqv.htm). See also the related articles on the web site at <http://www.microsoft.com/hwdev/stillimage/>.
- 22.24. **Applications provided with the device meet Win32 specifications**
Required
- 22.25. **Device driver supports TWAIN 1.7 or later**
Required
- 22.26. **Digital still image devices with an IR interface use the Windows Sockets interface**
Required
- 22.27. **Asynchronous imaging device with an IEEE 1394 interface uses SBP2Port**
Recommended

CHAPTER 2

References

This chapter presents all of the specifications and technical references discussed in *PC 99 System Design Guide*.

1394 Glass Optical Fiber Specification: *Proposal to Extend the P1394.b S-800–S1600 100m Glass Optical Fiber (GOF) Link Specifications*
<http://www.zayante.com/p1394b/GOFmedia/ts980709-GOF-Extension.pdf>

1394 Open Host Controller Interface Specification, Revision 1.0
<ftp://ftp.austin.ibm.com/pub/chrptech/1394ohci/ohcir100.pdf>

1394 Trade Association
E-mail: 1394-sig@1394ta.org
<http://www.1394ta.org>

1394 Trade Association Power Specification Part 1: Cable Power Distribution
1394 Trade Association Power Specification, Part 3: Power State Management
<ftp://ftp.p1394pm.org/pub/p1394pm/>

1997 Version of National ISDN Basic Rate Interface Terminal Equipment Generic Guidelines, Document Number SR-3888
Phone: (800) 521-2673 (North America)
(908) 699-5800 (Outside North America)
<http://www.bellcore.com>

Accelerated Graphics Port Interface Specification, Revision 1.0 and later
<http://developer.intel.com/pc-supply/platform/agfxport/>

Advanced Configuration and Power Interface Specification, Revision 1.0 and later
<http://www.teleport.com/~acpi/tech.htm>.

An Interoperable End-to-End Broadband Service Architecture over ADSL System
<http://www.microsoft.com/hwdev/network/dsl/>

ANSI/SMPTE standards
Recommended Practice (RP) 136 and time-code standard
Society of Motion Picture and Television Engineers
<http://www.smpte.org/stds/stsubj.html>

ANSI, TIA, and other standards
Global Engineering Documents
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(303) 792-2181 (Outside North America)

Fax: 1 (303) 397-2740

<ftp://ftp.symbios.com/pub/standards/io/>

ATA/ATAPI specifications and standards

AT Attachment 2 [X3T9.2 948D] and *AT Attachment 3* [X3T10 2008D] standards

ATA/ATAPI-4 Revision 17 Working Draft Standard (ATA/ATAPI-4)

ATA Packet Interface for CD-ROM (SFF 8020i)

ATAPI Removable Media BIOS Specification (ARMD), Version 1.0

Other ATA standards

Global Engineering Documents

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(613) 237-4250 (Canada)

(303) 792-2181 (Outside North America)

ATA and ATAPI draft standards and other working documents are available at

<ftp://fission.dt.wdc.com/pub/standards/> and

<ftp://ftp.symbios.com/pub/standards/io/>

ATM: The New Paradigm for Internet, Intranet & Residential Broadband Services and Applications, T. Kwok

Prentice Hall, 1998; ISBN 0-13-107244-7

ATM User-Network Interface Specification, Version 3.1

Prentice Hall; 1995 ISBN 0-13-393828-X

<http://www.atmforum.com/atmforum/specs/approved.html>

ATSC DTV Specification

Other Advanced Television Systems Committee (ATSC) standards

National Association of Broadcasters, (800) 368-5644

Society of Motion Picture and Television Engineers, (914) 761-1100

E-mail: mktg@smpte.org

http://www.atsc.org/Standards/stan_rps.html

Audio 98 Roadmap

Audio Codec 97 Component Specification

Audio Codec '97 Design Guide papers

<http://developer.intel.com/solutions/tech/audio.htm>

Audio Device Class Power Management Reference Specification, Version 1.0

<http://www.microsoft.com/hwdev/specs/pmref/pmaudio.htm>

Belcore Technical References

Belcore (Bell Communications Research)

Phone: (800) 521-2673 (North America)

(908) 699-5800 (Outside North America)

<http://www.bellcore.com>

Communications Device Class Power Management Reference Specification, Version 1.0

<http://www.microsoft.com/hwdev/specs/PMref/PMcom.htm>

- Compaq, Intel, Phoenix BIOS Boot Specification, Version 1.01*
<http://www.ptltd.com/techs/specs.html>
<http://www.microsoft.com/hwdev/respec/pnpspecs.htm>
- Default Device Class Power Management Specification, Version 1.0*
<http://www.microsoft.com/hwdev/specs/Pmref/PMdefault.htm>
- Device Bay Specification, Version 1.0*
<http://www.device-bay.org>
- Device Class Power Management Specifications
<http://www.microsoft.com/hwdev/specs/Pmref/>
- Digital Video Interface (DVI) Revision 1.0*
<http://www.ddwg.org>
- Display Data Channel Standard, Version 3.0, Level 2B protocols*
Video Electronics Standards Association (VESA)
Phone: (408) 435-0333
Fax: (408) 435-8225
<http://www.vesa.org/standards.html>
- Display Device Class Power Management Specification, Version 1.0*
<http://www.microsoft.com/hwdev/specs/Pmref/PMdisplay.htm>
- DLS Specification, Version 1.0 or later*
Downloadable Sounds (DLS) specification
MIDI Manufacturers Association
Fax: (714) 736-9775
E-mail: mma@midi.org
<http://www.midi.org/abtdls.htm>
- DTV and broadcast architecture
<http://www.microsoft.com/dtv/>
- DVB/DAVIC (Digital Video Broadcasting/Digital Audio-Visual Council)
<http://www.davic.org>
<http://www.dvb.org>
- ECMA Standards ECMA-267 (DVD-ROM), ECMA-274 (DVD+RW)
and ECMA-272, 273 (DVD-RAM)
<http://www.ecma.ch>
- Efficient Use of PCI, Platform Architecture Labs, Intel Corporation
<http://support.intel.com/support/chipsets/pc1001.htm>
- EIA Standard #ANSI/EIA-516-88: Joint EIA/CVCC Recommended Practice for
Teletext: North American Basic Teletext Specification (NABTS)
Electronic Industries Association
<http://www.tiaonline.org>
- El Torito—Bootable CD-ROM Format Specification, Version 1.0*
<http://www.ptltd.com/techs/specs.html>
- ETSI (European Telecommunication Standards Institute)
<http://www.etsi.fr>

European Telecommunications Standards Institute (ETSI) or Global System for Mobile (GSM) standards

Phone: +33-92 94 42 00

FAX: +33-93 65 47 16

E-mail: secretariat@etsi.fr

Extended Display Identification Data (EDID) Standard, Version 3.0

Video Electronics Standards Association (VESA)

Phone: (408) 435-0333

Fax: (408) 435-8225

<http://www.vesa.org>

FAT32 partition device driver support

<http://www.microsoft.com/hwdev/storage/>

Home Phoneline Networking Alliance (HomePNA)

<http://www.homepna.org>

Home Radio Frequency (Home RF) Working Group

<http://www.homerf.org>

IBM Personal System/2 Common Interfaces, Part No. S84F-9809

IBM Personal System/2 Mouse Technical Reference, Part No. S68X-2229

International Business Machines Corporation

Order from IBM Customer Publications Support: (800) 879-2755

Or contact an IBM sales representative

ICC Profile Format Specification, Version 3.4,

International Color Consortium

<http://www.color.org/profiles.html>

IEC 61883 Digital Interface for Consumer Electronic Audio/Video Equipment

<https://domino.iec.ch/webstore/webstore.nsf/Welcome?ReadForm>

IEEE 802.14 Cable TV Working Group

<http://www.walkingdog.com/>

IEEE 1394 Standards

ASK*IEEE

Phone: (800) 949-4333

Fax: (212) 310-4091

E-mail: askieee@ieee.org

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(613) 237-4250 (Canada)

(303) 792-2181 (Outside North America)

Fax: (303) 397-2740

Implementing Legacy Audio Devices on the PCI Bus

http://www.intel.com/pc-supp/platform/ac97/wp/leg_pci.htm

Infrared Extensions to the NDIS Version 4.0 Functional Specification

<http://www.microsoft.com/hwdev/infrared/irndis.htm>

Infrared Data Association specifications

Serial Infrared (SIR) Physical Layer Specification

Control IR (CIR or IrBUS) Specification

Other Infrared Data Association documents (available only to IrDA members)

Infrared Data Association

PO Box 3883

Walnut Creek, CA 94598 USA

Phone: (510) 943-6546

Fax: (510) 943-5600

E-mail: irda@netcom.com

Instantly Available PC System Power Delivery Requirements and Recommendations Specification

<http://developer.intel.com/design/power/supply98.htm>

Intel hardware developer site

<http://developer.intel.com>

Intel information about IEEE 1394 implementations

<http://developer.intel.com/technology/1394/>

Intel information about USB, including the UHCI design guide for USB

<http://developer.intel.com/design/litcentr/>

<http://developer.intel.com/design/usb/>

International Color Consortium (ICC)

ICC Profile Format Specification

<http://www.color.org>

Interoperability Specification for ICCs and Personal Computer Systems

<http://www.smartcardsys.com>

ISO/IEC 13213:1994 Control and Status Registers (CSR) Architecture for Microcomputer Buses

<http://www.iso.ch/cate/d21416.html>

ISO/IEC DIS 7816 Identification Cards—Integrated circuit(s) cards with contacts

Part 1: Physical characteristics

<http://www.iso.ch/cate/d29257.html>

Part 2: Dimensions and location of the contacts

<http://www.iso.ch/cate/d26536.html>

Part 3: Electronic signals and transmission protocols

<http://www.iso.ch/cate/d14735.html>

ITU (International Telecommunication Union) communications standards

ITU Sales

Phone: +41 (22) 730-6141

Fax: +41 (22) 730-5194

E-mail: sales@itu.ch

<http://www.itu.int/publications/index.html>

Low Pin Count Interface Specification

<http://developer.intel.com/design/chipsets/industry/lpc.htm>

- MCNS Data-Over-Cable Service Interface Specifications*
Now DOCSIS Specifications
<http://www.cablemodem.com/>
- Media Status Notification Support Specification, Version 1.03*
<http://msdn.microsoft.com/library/specs/atamed.htm>
<http://www.microsoft.com/HWDev/respec/storspec.htm>
- Microsoft DirectShow
<http://www.microsoft.com/directx/overview/dshow/>
- Microsoft DirectX 5.0 SDK; Microsoft Platform SDK; Microsoft WMI SDK
MSDN Professional membership
- Microsoft Windows 98 DDK, Windows 2000 DDK, and DirectX 5.0 DDK
<http://www.microsoft.com/ddk/>
(or MSDN Professional membership)
- MMC-2 Multi-Media Command Set-2*
<ftp://ftp.symbios.com/pub/standards/io/t10/drafts/mmc2/>
- Mobile Power Guidelines '99, Revision 1.0*
<http://developer.intel.com/design/mobile/intelpower/>
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Intel part number 242016-002
<http://developer.intel.com/design/pro/datashts/242016.htm>
- Multisession Compact Disc Specification Enhanced Music CD Specification, Version 1.0*
Philips Consumer Electronics B.V.
Coordination Office OpticalMagnetic Media Systems
Building SWA-109, PO Box 80002
5600 JB Eindhoven, The Netherlands
Fax: (31) (40) 732113
- National Committee for Information Technology Standards (NCITS) Reduced Block Commands (RBC) Draft Proposal T10/97-260r0*
<ftp://ftp.symbios.com/pub/standards/io/t10/drafts/rbc/>
- Network Device Class Power Management Reference Specification, Version 1.0a*
<http://www.microsoft.com/hwdev/specs/PMref/PMnetwork.htm>
- Network PC System Design Guidelines, Version 1.0b*
<http://www.microsoft.com/hwdev/netpc.htm>
<http://developer.intel.com/ial/WfM/design/NETREC.HTM>
- New Key Support for Microsoft Windows Operating Systems and Applications*
(replacement reference)
<http://www.microsoft.com/hwdev/desinit/scancode.htm>
- OpenGL conformance rules from the OpenGL Architectural Review Board
<http://www.sgi.com/software/opengl/faq.html>
UseNet news group for OpenGL at comp.graphics.opengl
- OpenHCI: Open Host Controller Interface Specification for USB, Release 1.0a*
<http://www.microsoft.com/hwdev/respec/busspecs.htm>

OSTA MultiRead Specification for CD-ROM, CD-R, CD-R/W, and DVD-ROM Devices, Version 1.11

<http://www.osta.org>

PC Card Controller Device Class Power Management Reference Specification, Version 1.0

<http://www.microsoft.com/HWDev/specs/PMref/PMcard.htm>

PC Card Display Tuple diagnostic utility (Dtpl.exe)

<http://www.microsoft.com/HWDev/busbios/dtpl.htm>

PC Card Standard Guidelines

PCMCIA

2635 North First Street, Suite 209

San Jose, CA 95134 USA

Phone: (408) 433-2273

Fax: (408) 433-9558

E-mail: office@pcmcia.org

<http://www.pc-card.com/bookstore.htm>

PC/Smart Card (PC/SC) Workgroup

<http://www.smartcardsys.com>

PCI information, including Microsoft testing tools, specifications, white papers and other related articles

E-mail: pciinfo@microsoft.com

<http://www.microsoft.com/hwtest/>

<http://www.microsoft.com/hwdev/pci/>

PCI specifications

PCI Bus Power Management Interface Specification, Revision 1.0 and later

PCI Bus Power Management Interface Specification for PCI to CardBus Bridge, Revision 1.0

PCI Local Bus Specification, Revision 2.1 (PCI 2.1) and later

PCI to PCI Bridge Specification, Revision 1.0.

PCI SIG

Phone: (800) 433-5177

<http://www.pcisig.com/specs.html>

PCMCIA standards

PCI to PCMCIA CardBus Bridge Register Description (Yenta specification)

PCMCIA

2635 North First Street, Suite 209

San Jose, CA 95134 USA

Phone: (408) 433-2273

Fax: (408) 433-9558

E-mail: office@pcmcia.org

<http://www.pc-card.com/bookstore.htm>

Personal Computer Audio Quality Measurement Definitions,

by Dr. Steven Harris and Cliff Sanchez, Crystal Semiconductor

<http://www.cirrus.com/products/papers/meas/meas.html>

Plug and Play specifications

Plug and Play External COM Device Specification, Version 1.0

Plug and Play Industry Standard Architecture (ISA) Specification, Version 1.0a
and *Clarification to Plug and Play ISA Specification, Version 1.0a*

Plug and Play Parallel Port Device Specification, Version 1.0b

Plug and Play SCSI Specification, Version 1.0

<http://www.microsoft.com/hwdev/respec/pnpspecs.htm>

<http://msdn.microsoft.com/library/>

SCSI draft standards and other working documents

<ftp://ftp.symbios.com/pub/standards/io/t10/>

SFF 8090 (Mt. Fuji specification)

Other SFF Committee publications and specifications

FaxAccess: (408) 741-1600 (fax-back)

Fax: (408) 867-2115

<ftp://fission.dt.wdc.com/pub/standards/SFF/specs/>

Simple Boot Flag Specification, Version 1.0

http://www.microsoft.com/hwdev/desinit/simp_bios.htm

Small Computer Interface (SCSI-2) [X3T9.2-375R] standard

Small Computer Interface (SCSI-3) Parallel Interface (SPI) [X3T9.2/91-10] standard

Other SCSI standards and documents

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(613) 237-4250 (Canada)

(303) 792-2181 (Outside North America)

Small Form Factor (SFF) Committee publications

FaxAccess: (408) 741-1600 (fax-back)

Fax: (408) 867-2115

Smart Battery specifications

Smart Battery Charger Specification, Version 1.0

Smart Battery Data Specification, Version 1.0

Smart Battery Selector Specification, Version 1.0

Smart Battery System Manager Specification, Version 1.0

<http://www.sbs-forum.org/specs/index.html>

SMART IOCTL API Specification, Version 1.1

<http://www.microsoft.com/hwdev/respec/storspec.htm>

Standard Signaling Method for a Bi-directional Parallel Peripheral Interface for Personal Computers (IEEE 1284 specification)

ASK*IEEE

Phone: (800) 949-4333

Fax: (212) 310-4091

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(613) 237-4250 (Canada)

(303) 792-2181 (Outside North America)

Storage Device Class Power Management Reference Specification, Version 1.0

<http://www.microsoft.com/hwdev/specs/PMref/PMstore.htm>

System Management BIOS Reference Specification, Version 2.2

<ftp://download.intel.com/ial/wfm/smbios.pdf>

<http://www.phoenix.com/techs/specs.html>

Unimodem Diagnostics Command Reference Specification

<http://www.microsoft.com/hwdev/respec/commspec.htm>

Universal Disk Format Specification, Version 1.5 and 2.0

<http://www.osta.org>

USB specifications and USB Implementers Forum:

Definitions for Communications Devices, Version 1.0

USB Common Class Base Specification, Revision 1.0

USB Device Class Definition for Audio Devices, Version 0.9

USB Device Class Definition for Human Interface Devices (HID), Version 1.0

USB Device Class Definition for Mass Storage Devices, Revision 1.09

USB Device Class Definition for Printing Devices, Version 1.0

USB HID Usage Tables, Version 1.0

USB Imaging Class Specification

USB Monitor Control Class Specification, Revision 1.0

USB PC Legacy Compatibility Specification, Revision 0.9 or later

USB Specification, Version 1.0 or later

USB Usage Tables for HID Power Devices, Release 1.0

Phone: (503) 264-0590

Fax: (503) 693-7975

<http://www.usb.org/developers/index.html>

VESA BIOS Extension Standard/Core Functions 2.0 (VBE/Core 2.0)

VESA Display Data Channel Standard

VESA and Industry Standards and Guidelines for Computer Display Monitor Timing

VESA Video Interface Port (VIP) Specification

Video Electronics Standards Association (VESA)

Phone: (408) 435-0333

Fax: (408) 435-8225

<http://www.vesa.org/standards.html>

Video Essentials test disc from Joe Kane Productions, Inc.

<http://www.videoessentials.com>

Videophone-Ready Modem Handbook Specification, Version 1.0

<http://developer.intel.com/IAL/vidred/index.htm>

Web-Based Enterprise Management (WBEM) information

<http://www.dmtf.org/wbem/>

<http://www.microsoft.com/management/wbem/>

White papers and guidelines for Microsoft operating systems

Audio: <http://www.microsoft.com/HWDev/specs/PMref/PMaudio.htm>

CardBus: <http://www.microsoft.com/hwdev/cardbus/>

DirectDraw VPE and kernel-mode video transport:

<http://www.microsoft.com/hwdev/devdes/vpe.htm>

Display and Video Technology: <http://www.microsoft.com/hwdev/video/>

DTV: <http://www.microsoft.com/dtv>

IEEE 1394: <http://www.microsoft.com/hwdev/1394/>

I/O Ports and Devices: <http://www.microsoft.com/hwdev/input/>

Modem, Unimodem: <http://www.microsoft.com/hwdev/modem/>

Multiple-monitor/multiple-adapter support:

<http://www.microsoft.com/hwdev/video/>

NDIS and Windows networking white papers:

<http://www.microsoft.com/ntserver/commserv/>

<http://www.microsoft.com/hwdev/network/>

Printing: <http://www.microsoft.com/hwdev/print/>

Still Image Architecture: <http://www.microsoft.com/hwdev/stillimage/>

Storage: <http://www.microsoft.com/hwdev/storage/>

Telephony API (TAPI) overview:

<http://www.microsoft.com/ntserver/commserv/exec/overview/telephony.htm>

USB: <http://www.microsoft.com/hwdev/usb/>

Video and Broadcast Components: <http://www.microsoft.com/hwdev/bpc/>

WDM driver support: <http://www.microsoft.com/hwdev/wdm/>

WMI: <http://www.microsoft.com/hwdev/manageability/>

Windows Hardware Instrumentation Implementation Guidelines (WHIIG), Version 1.0

<http://www.microsoft.com/hwdev/desguid/whiig.htm>

Wired for Management Baseline Specification

Version 1.1a <http://developer.intel.com/ial/WfM/design/BIBLIOG.HTM>

Version 2.0 <http://developer.intel.com/ial/wfm/>

Yenta specification

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